SUPPLEMENT TO "CURRENT SCIENCE".

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Inaugural Address.

By Sir James Jeans, D.Sc., Sc.D., LL.D., F.R.S.,
Congress President.

UNTIL a very few weeks ago, we had hoped to assemble here under the Presidency of one of the greatest scientists of all time, and it is inevitable that his sudden and tragic death should be uppermost, not only in the thoughts of those of us who come from Europe, most of whom knew him personally, but in the thoughts of everyone here. For his works had made him known to us all. He has been cut off in the fulness of his powers—leaving as his monument a rich and full life's work, such as few men have equalled, but also leaving a feeling that he might have accomplished more, and possibly even greater, things had he been left with us a few years longer.

Those of us who were honoured by his friendship know that his greatness as a scientist was matched by his greatness as a man. We remember, and always shall remember, with affection his big, energetic, exuberant personality, the simplicity, sincerity and transparent honesty of his character, and, perhaps most of all, his genius for friendship and good comradeship. Honours of every conceivable kind had been showered upon him, so that he could not but know of the esteem in which he was held by the whole world, and yet was always simple, unassuming and ready to listen patiently to even the youngest and most inexperienced of his pupils or fellow-workers, if only he were honestly seeking for scientific truth.

This is neither the place nor the occasion to attempt any detailed description of his scientific achievements. A great physicist, Niels Bohr—whom we are sorry not to have with us here—speaking of Rutherford's work to a congress of physicists which recently met in Bologna, said: 'His achievements are so great that, at a gathering of physicists like the one here assembled, they provide the background of almost every word that is spoken.' As it was in Bologna, so it will be in Calcutta; the proceedings in our physics section will be utterly different from what they would have been had Rutherford not lived and worked. And it is sad to think that they will be utterly different from what they would have been had he lived even a few months longer, for then we should have had his ardent and inspiring personality and vast fund of knowledge and experience to direct and enliven our debates. Happily he will not be altogether absent from our meeting. He had been looking forward with the greatest interest and eagerness to this occasion, and had already written a Presidential Address for it, which it will be my duty to read to you very shortly.

In this he tells us, in his own words, of his latest work of all—that in nuclear physics, and especially in what he described as 'the new alchemy', the transmutation of the elements. This alone would have ensured him a place in the foremost rank of physicists, and yet it formed only a small part of the total achievements of his life.

When I first knew him, almost exactly forty years ago, he was experimenting in wireless telegraphy, using a detector of his own invention, and transmitting signals

to what was, for those times, the record distance of about a mile and a half.

That was in the period which he used himself to describe as 'the heroic age of physics'. Within the space of a very few years, Röntgen rays were discovered and provided a new line of attack on the problems of electric conduction in gases; the electron was isolated, and seemed to point the way to an understanding of the age-long puzzle of the structure of matter; radio-activity was discovered, with its apparent violation of well-established physical laws, and opened up a new road which led no one knew where—but obviously into very different territory from that which nineteenth century physics had so industriously and thoroughly explored.

Rutherford directed his colossal energy and tireless enthusiasm on to all these vast new problems in turn. By a few investigations of masterly simplicity, he reduced the puzzling phenomena of radio-activity to law and order, and, in collaboration with Soddy, discovered the physical interpretation of this law and order. Radio-activity, they found, indicated the transmutation of one element into others through processes of spontaneous atomic explosion.

Rutherford then treated the α-particles which were emitted at these radio-active explosions as projectiles. He bombarded atoms with them and in so doing discovered the composition of the atoms. Finally he shewed how similar bombardments could change the constitution of the atomic nuclei, and so literally transmute the elements; the dream of the alchemists was realized.

These were perhaps the outstanding landmarks in his career, but in truth most of his investigations were key investigations, each brilliant in its simplicity of conception, masterly in its execution and far-reaching in its consequences. His output of work was enormous and can only be explained by his capacity for delegating all the less important details of an investigation to a collaborator, whom he usually inspired with his own enthusiasm. In his flair for the right line of approach to a problem, as well as in the simple directness of his methods of attack, he often reminds us of Faraday, but he had two great advantages which Faraday did not possess—first, exuberant bodily health and energy, and second, the opportunity and capacity to direct a band of enthusiastic co-workers. Great though Faraday's output of work was, it seems to me that to match Rutherford's work in quantity as well as in quality, we must go back to Newton.

Voltaire once said that Newton was more fortunate than any other scientist could ever be, since it could fall to only one man to discover the laws which governed the universe. Had he lived in a later age, he might have said something similar of Rutherford and the realm of the infinitely small; for Rutherford was the Newton of atomic physics. In some respects he was more fortunate than Newton: there was nothing in Rutherford's life to compare with the years which Newton spent in a vain search for the philosopher's stone or, with Newton's output of misleading optical theories, or with his bitter quarrels with his contemporaries. Rutherford was ever the happy warrior—happy in his work, happy in its outcome, and happy in its human contacts.

Through the tragic circumstance of his death, I stand before you as your President. I cannot tell you how greatly honoured I feel by your choice, but neither can I tell you how strongly I feel my utter inadequacy to act as substitute for the really great man we had all hoped to have with us here.

Presidential Address.

By (The late) Prof. The Rt. Hon. Lord Rutherford of Nelson, O.M., F.R.S., D.Sc., LL.D., Ph.D.

(Read by Sir James Jeans.)

Transmutation of Matter.

[The first portion of the Presidential Address deals briefly with the "Contributions to scientific knowledge made in India and the needs of the immediate future, if science is to play its part in the national welfare". The portion referring to "Transmutation of matter" is reproduced below.]

I HAVE so far spoken of the importance of science as a factor in national development, but before concluding my address, I would like to refer to some investigations in pure science in which I have been personally much interested. I refer to the successful attack on that age-old problem of the transmutation of matter which in recent years has attracted so much attention from physicists throughout the world.

I hope it may prove of interest to give a brief account of the successive stages of the growth of our knowledge of this subject, for it illustrates in a striking manner the power of the scientific method of attack on what at first appeared to be an insoluble problem. Incidentally these researches have yielded us precious information on the structure of all atoms and indeed it seems likely to have provided us with a key, so to speak, to unlock the secrets of the constitution of our material world.

Towards the close of the nineteenth century, when it seemed certain that the atoms of the elements were unchangeable by the forces then at our command, the discovery was made which has revolutionized our conception of the nature and relations of the elements. I refer to the discovery in 1896 of the radio-activity of the two heaviest elements uranium and thorium. It was soon made clear that this radioactivity is a sign that the atoms of these elements are undergoing spontaneous transmutation. At any moment, a small fraction of the atoms concerned becomes unstable and breaks up with explosive violence, hurling out either a charged atom of helium, known as an α-particle, or an electron called in this connection a β-particle. As a result of these explosions, a new radioactive element is formed and the process of transmutation once started continues through a number of stages. Each of the radioactive elements, formed in this way, breaks up according to a simple universal law but at very different rates. In a surprisingly short time, these successive transformations were disentangled and more than 30 new types of elements brought to light while the simple chemical relations between them were soon made clear.

We had thus been given a vision of a new and startling sub-atomic world where atoms break up spontaneously with an enormous release of energy, quite uninfluenced by the most powerful agencies at our disposal. Apart from uranium and thorium and the elements derived from them, only a few other elements showed even a feeble trace of radioactivity. The great majority of our ordinary elements appeared to be permanently stable under ordinary conditions on our earth. Science was then faced with the problem whether artificial methods could be found to transmute the atoms of the ordinary elements. Before this problem could be attacked with any hope of success, it was necessary to know more of the actual constitution of atoms. This information was provided by the rise of the nuclear theory of the atomic structure which I first suggested in 1911. The essential controlling feature of all atoms was found to reside in a very minute central nucleus which carried a positive charge and contained most of the mass of the atom. A relation of unexpected simplicity was found to connect the atoms of all the elements. The ordinary properties of an atom are defined by a whole number which represents the number of units of resultant positive charge carried by the nucleus. This varies from 1 for hydrogen to 92 for the heaviest element uranium and with few exceptions all the intervening numbers correspond to known elements.

On this view of atomic structure, it was evident that, to bring about the transmutation of an atom, it was necessary in some way to alter the charge or mass of the nucleus or both together. Since the nucleus of an atom must be held together by very powerful forces, this could only

be effected by bringing a concentrated source of energy in some way to bear on the individual nucleus. The most energetic projectile available at that time was the α-particle spontaneously ejected from radioactive substances. If a large number of α-particles were fired at random at a sheet of matter, it was to be expected that one of them must occasionally approach very closely to the nucleus of any light atom in its path. In such a close encounter, the nucleus must be violently disturbed, and possibly under favourable conditions the α-particle might actually enter the nuclear structure, resulting in a transformation of the nucleus.

This mode of attack upon the nucleus at once proved successful. I found in 1919 that nitrogen could be transformed by bombardment with fast α-particles. The process of transmutation is now clear. Occasionally an α-particle actually enters the nitrogen nucleus and forms with it a new unstable nucleus which instantly breaks up with the emission of a fast proton (hydrogen nucleus) and the formation of a stable isotope of oxygen of mass 17. About a dozen of the light elements were found to be transformed in a similar way. The protons liberated in the nuclear explosions were at first counted by observing the flashes of light (scintillations) produced in phosphorescent zinc sulphide. This method was slow and very trying to the eyes of the observers. Progress however became more rapid and definite when electrical methods of counting individual fast particles were developed. These electrical counters, mainly depending on the use of electron-tubes for magnifying small currents, have now reached such a stage of perfection that we are able to count automatically individual fast particles like α-particles and protons, even though they enter the detecting chamber at a rate as fast as ten thousand per minute. By other special devices, we are in like manner able to count individual β-particles. In this connection, I must also mention that wonderful instrument the Wilson Expansion Chamber which makes visible to us the actual tracks of flying fragments of atoms resulting from an atomic explosion. These remarkable devices have played an indispensable part in the rapid growth of knowledge during the last few years. It is to be emphasized that progress in scientific discovery is greatly influenced by the development of new technical methods and of new devices for measurement. With the growing complexity of science, the development of special techniques is of ever-increasing importance for the advance of knowledge.

Up to the year 1932, experiments on transmutation were confined to the use of α-particles for bombarding purposes. It became clear that the process of transformation was in most cases complex, since groups of protons with different but characteristic energies were observed when a single element was bombarded. This led to the conception that discrete energy levels existed within a nucleus and that under some conditions part of the excess energy was sometimes released in the form of a quantum of high frequency radiation.

The stage was now set for a great advance, and four new discoveries of outstanding importance were made in rapid succession in the period 1932–33. I refer to the discovery of the positive electron by Anderson in 1932, of the neutron by Chadwick in 1932, of artificial radioactivity by M. and Mme. Curie-Joliot in 1933 and of the transmutation of the elements by purely artificial methods first shown by Cockcroft and Walton in 1932.

The discovery of the neutron—that uncharged particle of mass nearly 1—was the result of a close study of the effects produced in the light element beryllium when bombarded by α-particles. It is noteworthy that the proton and the neutron, which are now believed to be the essential units with which all the atomic nuclei are built up, owe their recognition to a study of the transmutation of matter by α-particles.

Before the discovery of the neutron, it had been perforce assumed that nuclei must in some way be built up of massive protons and light negative electrons. Theories of nuclear structure became much more amenable to calculation when the nucleus is considered to be an aggregate of particles like the proton and neutron which have nearly the same mass. There was no longer any need to assume that either the positive or the negative electron has an independent existence in the nuclear structure. We are still uncertain of the exact relation, if any, between the neutron and the proton. The neutron appears to be slightly more massive than the proton but it is generally believed

although no definite proof is available, that the proton and neutron within a nucleus are mutually convertible under certain conditions. For example, the change of a proton into a neutron within the nucleus should lead to the appearance of a free positive electron, while conversely the change of a neutron into a proton gives rise to a free negative electron. In this way it appears possible to account for the observed fact that either positive or negative electrons are emitted by a large group of radioactive elements, to which I will now refer.

In the early experiments on transmutation by α-particles, it was supposed that a stable nucleus was always formed after the emission of a fast proton. The investigations of M. and Mme. Curie-Joliot showed that in some cases elements were formed which, while apparently stable, ultimately broke up slowly, exactly like the natural radioactive bodies. Most of these radioactive bodies, formed by artificial methods, break up with the expulsion of fast negative electrons, but in a few cases positive electrons are emitted. Since the presence of these radioactive bodies can be easily detected, and their chemical properties readily determined, this new method of attack on the problem of transmutation has proved of great value. Nearly a hundred of these radioactive bodies are now known, produced in a great variety of ways. Some arise from the bombardment by fast α-particles, others by bombardment with protons or deuterons. As Fermi and his colleagues have shown, neutrons and particularly slow neutrons are extraordinarily effective in the formation of such radioactive bodies. On account of its absence of charge, the neutron enters freely into the nuclear structure of even the heaviest element, and in many cases causes its transmutation. For example, a number of these radioactive bodies are produced when the two heaviest elements uranium and thorium are bombarded by slow neutrons. In the case of uranium, as Hahn and Meitner have shown, the radioactive bodies so formed break up in a succession of stages like the natural radioactive bodies, and give rise to a number of transuranic elements of higher atomic number than uranium (92). These radioactive elements have the chemical properties to be expected from the higher homologues of rhenium, osmium and iridium of atomic numbers 93, 94 and 95 respectively.

These artificial radioactive bodies in general represent short-lived varieties of the isotopes of known elements. No doubt such transient radioactive elements are still produced by transmutation in the furnace of our sun where the thermal motions of the atoms must be very great. These radioactive elements would rapidly disappear as soon as the earth cooled down after separation from the sun. On this view, uranium and thorium are to be regarded as practically the sole survivors in our earth of a large group of radioactive elements owing to the fact that their time of transformation is long compared with the age of our planet.

It is of interest to note what an important part the α-particle, which is itself a product of transformation of the natural radioactive bodies, has played in the growth of our knowledge of artificial transmutation. It is to be remembered too that our main source of neutrons for experimental purposes is provided by the bombardment of beryllium with α-particles. The amount of radium available in our laboratories is, however, very limited, and it was early recognized that if our knowledge of transmutation was to be extended, it was necessary to have a copious supply of fast particles of all kinds for bombarding purposes. It is well known that enormous numbers of protons and deuterons, for example, can be easily produced by the passage of the electric discharge through hydrogen and deuterium (heavy hydrogen). To be effective for transmutation purposes, however, these charged particles must be given a high speed by accelerating them in a strong electric field. This has involved the use of apparatus on an engineering scale to provide voltages as high as one million volts or more and the use of fast pumps to maintain a good vacuum.

A large amount of difficult technical work has been necessary to produce such high direct voltages, and to find the best methods of applying them to the accelerating system. In Cambridge, these high voltages are produced by multiplying the voltage of a transformer by a system of condensers and rectifiers; in the U.S.A. by the use of a novel type of electrostatic generator, first developed by van der Graaf. Prof. E. O. Lawrence of the University of California has devised an ingenious instrument called a 'cyclotron', in which the charged particles are automatically accelerated in multiple stages. This involves the use of huge

electromagnets and very powerful electric oscillators. By this method, he has succeeded in producing streams of fast particles which have energies even higher than α-particles ejected from radioactive substances. Undoubtedly this type of apparatus will prove of great importance in giving us a supply of much faster particles than we can hope to produce by the more direct methods.

It was at first thought that very high potentials of the order of several million volts would be required to obtain particles to study the transmutation of elements. Here, however, the development of the theory of wave-mechanics came to the aid of the experimenter, for Gamow showed that there was a small chance that comparatively slow bombarding particles might enter a nucleus. This theoretical conclusion has been completely verified by experiment. In the case of a light element like lithium, transformation effects can be readily observed with protons of energy as low as 20,000 volts. Of course, the possibility of transformation increases rapidly with rise of voltage.

The study of the transmutation of elements by using accelerated protons and deuterons as bombarding particles has given us a wealth of new information. The capture of the proton or deuteron by a nucleus leads in many cases to types of transmutation of unusual interest. For example, the bombardment of the isotope of lithium of mass 7 by protons leads to the formation of a beryllium nucleus of mass 8 with a great excess of energy. This immediately breaks up with two α-particles shot out in nearly opposite directions. When boron of mass 11 is bombarded by protons, a carbon nucleus of mass 12 is formed which breaks up in most cases into three α-particles. The deuteron is in some respects even more effective than the proton as a transmuting agent. When deuterons are used to bombard a compound of deuterium, previously unknown isotopes of hydrogen and of helium of mass 3 are formed, while fast protons and neutrons are liberated. The bombardment of beryllium by very fast deuterons gives rise to a plentiful supply of neutrons. Lawrence has shown that the bombardment of bismuth by very fast deuterons leads to the production of a radioactive bismuth isotope which is identical with the well-known natural radioactive product radium E. Many artificial radioactive elements can be produced often in great intensity. For example, the bombardment of common salt by fast deuterons gives rise to a radioactive isotope of sodium. This breaks up with a half period of 15 hours, emitting not only fast β-particles but γ-rays at least as penetrating as those from radium.

It may well be that in course of time such artificial radioactive elements may prove a useful substitute for radium in therapeutic work. By these methods also, such intense sources of neutrons can be produced that special precautions have to be taken for the safety of the operators of the apparatus.

Sufficient I think has been said to illustrate the variety and interest of the transmutations produced by these bombardment methods. It should, however, be pointed out that transmutation in some cases can be effected by transferring energy to a nucleus by means of gamma rays of high quantum energy instead of by a material particle. For example, the deuteron can be broken up into its components, the proton and neutron, by the action of the gamma rays from radium or thorium. As a result of the bombardment of lithium by protons, gamma rays of extraordinarily high energy up to 17 million volts are strongly emitted. Bothe has recently shown that these high energy rays are able to transmute a number of atoms, neutrons usually being emitted in the process.

Some simple laws appear to hold in all individual transformations so far examined. Nuclear charge is always conserved, and where heavy particles are emitted, so also is energy when account is taken of the equivalence of mass and energy. Certain difficulties arise with regard to the conservation of energy in cases where light positive and negative electrons are emitted during transmutation, and there is still much discussion on this important question.

The study of the transmutation of matter has been extraordinarily fruitful in results of fundamental importance. In addition to the α-particle, it has disclosed to us the existence of those two building units of nuclei, the proton and neutron. It has greatly widened our conception of the varieties of atomic nuclei which can exist in nature. Not only has it led to the discovery of about one hundred new radioactive elements, but also of several stable isotopes of known elements like ^{3}H, ^{3}He, ^{8}Be which had previously been unsuspected. It has greatly extended our knowledge of

the ways in which nuclei can be built up and broken down, and has brought to our attention the extraordinary violence of some of the nuclear explosions which occur. The great majority of our elements have been transmuted by the bombardment method, and in the case of the light elements which have been most carefully studied, a great variety of modes of transmutation have been established.

Rapid progress has been made but much still remains to be done before we can hope to understand the detailed structure and stability of different forms of atomic nuclei and the origin of the elements. I cannot but reflect on the amazing contrast between my first experiment on the transmutation of nitrogen in the University of Manchester in 1919 and the large-scale experiments on transmutation which are now in progress in many parts of the world. In the one case, imagine an observer in a dark room with very simple apparatus painfully counting with a microscope a few faint scintillations originating from the bombardment of nitrogen by a source of α-particles. Contrast this with the large-scale apparatus now in use for experiments on transmutation in Cambridge. A great hall contains massive and elaborate machinery, rising tier on tier, to give a steady potential of about two million volts. Nearby is the tall accelerating column with a power station on top, protected by great corona shields—reminding one of a photograph in the film of Wells's 'Things to Come'. The intense stream of accelerated particles falls on the target in the room below with thick walls to protect the workers from stray radiation. Here is a band of investigators using complicated electrical devices for counting automatically the multitude of fast particles arising from the transformation of the target element or photographing with an expansion chamber, automatically controlled, the actual tracks of particles from exploding atoms.

To examine the effect of still faster particles, a cyclotron is installed in another large room. The large electromagnet and accessories are surrounded with great water tanks containing boron in solution to protect the workers from the effect of neutrons released in the apparatus. A power station nearby is needed to provide current to excite the electromagnet and the powerful electric oscillators.

Such a comparison illustrates the remarkable changes in the scale of research that have taken place in certain branches of pure science within the last twenty years. Such a development is inevitable, for, as science progresses, important problems arise which can only be solved by the use of large powers and complicated apparatus, requiring the attention of a team of research workers. If rapid progress is to be made, such team work is likely to be a feature of the more elaborate researches in the future. Fortunately, there is still plenty of scope for the individual research worker in many experiments of a simpler kind.

The Science of Physics now covers such a vast field that it is impossible for any laboratory to provide up-to-date facilities for research in more than a few of its branches. There is a growing tendency in our research laboratories to-day to specialize in those particular branches of Physics in which they are most interested or specially equipped. Such a division of the field of research amongst a number of universities has certain advantages, provided that this subdivision is not carried too far. In general, the universities should be left free as far as possible to develop their own lines of research and encouraged to train young investigators, for it cannot be doubted that vigorous schools of research in pure science are vital to any nation if it wishes to develop effectively the application of science, whether to agriculture, industry or medicine. Since investigations in modern science are sometimes costly and often require the use of expensive apparatus and large-scale collaboration, it is obviously essential that adequate funds should be available to the universities to cover the cost of such researches.

the objectives of conservation as envisaged and pursued in other countries and a careful examination of the extent of the applicability of such programmes to the special needs and conditions of India.

Within the compass of a single book the editors have brought together a wealth of information—varied and detailed—hardly excelled by the expert reports of commissions and conferences. For the purpose of a logical presentation of the numerous problems comprehended by the book, it is divided into ten parts, each part being relatively complete within itself. Great attention is paid throughout the book to the extent and distribution of the natural resources, and to their service to the regional and national development. Each problem discussed is viewed as the outgrowth of natural and cultural conditions in specific parts of the states, and emphasis is placed on the natural and human factors involved in the growth of fresh problems. Every division of the book presents a balanced and concrete conception of the resources and the underlying problems in this appropriate setting as a part of the organic units of the different states.

The book contains a treasure of information. Its outlook is scientific and its contents are inspiring. Every chapter deals with a specific topic, written by an author who has an expert knowledge and the whole book is copiously illustrated by figures and statistical tables. A selected Bibliography of the more valuable references as a guide for further study bearing on each chapter is appended, which together with the maps of the United States in relief, and others illustrating the physiographical features and mean rainfall, adds to the general interest and usefulness of the book. This book is indispensable to the administrator, students of economics and social sciences and to all practical men of public affairs.

Graded and Everyday Examples in Physics. By Johns, Ware and Rees. (Macmillan & Co., Ltd., London), 1937. Pp. xii + 407. Price 6*s*.

The book is a very good collection of examples in Physics suitable for Intermediate students. The exercises are made to touch practical life as far as possible and here we do not hear of soft iron magnets or steel pole faces and similar incongruities. The values of the data given are true to life, and working these examples will fix some useful information in the mind of the pupil. Numerical values are usually chosen so that arithmetical calculation is as simplified as possible. The model examples are set out in an admirable manner and if copying such a model is insisted on, we may expect a great profit to be gained by students in clarity, care and neatness. Very short summaries of principles and formulæ are prefixed to the worked examples. We should like to suggest a few alterations in this part: for example, on page 17, the formula $p = hd$, though correct as far as numerical values in gravitational units are concerned, leads to a wrong conception of dimensions since it is not expressly stated that p is in gravitational units. On page 77, line 14, there is an excessive 'of the'. On page 185, PV = Const., P/T = Const., and V/T = Const. are treated as three independent experimental results whereas only two of them are so independent. In the convention of signs for lenses and mirrors, the origin of measurement is not expressly stated. On page 247, I/O is called "the magnification (or the magnifying power) of the lens" as if it were characteristic of the lens. On page 280, a sonometer wire is said to be tightly clamped at its ends, whereas it is only supported on bridges. The unit of magnetic field intensity is called gauss instead of the name oersted. We are sure these minor alterations will be made in the next edition which we may expect soon to be in demand, considering the excellence of the examples and their suitability to the Intermediate classes of the Indian Universities. T. S. S.

High-Speed Diesel Engines. By Arthur W. Judge. (Published by Chapman & Hall, Ltd., London), 1937. Third Edition. Pp. 430. 360 Figures. Price 18*s*. net.

This book which has reached its third edition since 1933 is written by a well-known authority on internal combustion engines and associated subjects and deals with an important development in this type of engine which is of considerable interest to many not engaged in, as well as those who are engaged in, the internal combustion engine industry. Although the advantages following on the higher efficiency of the high-speed compression ignition engine are

of considerable interest to those concerned with the production and utilisation of such engines it is probable that its possibilities in the matter of reduced (and perhaps eliminated) fire risk in aircraft will appeal far more strongly to the average engineer and scientist. This arises from two of its features, *viz.*, the absence of sparking device and the much dangerous nature (higher flash point) of the fuel used. The other advantages resulting from its higher efficiency (than the petrol engine) are probably only of secondary interest to the majority of readers compared with the paramount importance of the other considerations.

Its chief disadvantage for aircraft purposes is its greater weight compared with the petrol engine and it will probably always suffer from this handicap. Owing to its distinctive characteristic, *viz.*, its high compression, which is normally more than twice that of the petrol engine, the ratio of maximum to mean pressure will always be higher than in the case of the petrol engine. Since an engine must be designed to withstand the maximum pressure, the parts of the former will always be heavier. This higher weight of engine is however partly or wholly offset by the reduced weight of fuel in the case of long-distance flying.

Other interesting aspects are the possibilities in the two-stroke type of internal combustion engine. This arises out of the fact that the leakage between the transfer port and the exhaust port is only leakage of air, since the fuel is injected at the top of the stroke and not leakage of fuel as in the ordinary two-stroke petrol engine.

The subject is very clearly dealt with and the book is easy to read. A brief history of the compression ignition principle is appropriately given, forming an interesting introduction to the subject, and the account of the development to the present time makes interesting reading. The division of the subject-matter into principles and practical means of applying them very much facilitates the ease with which the subject can be absorbed. A long chapter is devoted to the all-important subject of fuel injection systems followed by chapters on the chief types of automobile, aircraft and other types of engine at present manufactured.

It is a pity that a little more attention was not given to the lettering of the diagrams.

K. ASTON.

Gmelins Handbuch der anorganischen Chemie. (8 Auflage, System Nummer 22, Kalium).—Lieferung 1, 1936, pp. 1–246, Price RM. 28·50; Lieferung 2, 1937, pp. 247–514, Price RM. 31·50; Lieferung 3, 1937, pp. 515–814, Price RM. 35·25. (Verlag Chemie, G.m.b.H., Berlin.)

In Lieferung 1 the references have been brought up to April 1936. The treatment, as is usual with the Gmelins series, is comprehensive and critical. The first 62 pages deal with the occurrence of potassium in the extra-terrestrial regions, such as the sun, stars and meteorites, and then on the earth, each country receiving individual attention. It may be of interest to note that the "potassium content of the salts after the natural evaporation of the water of Sambhar (wrongly spelt 'Sambhan') lake, Rajputana, India, amounts to 11·5 to 13 per cent. KCl".

The physical and chemical properties of the element and methods of estimation take up more than 130 pages, and the compounds of potassium with hydrogen and oxygen the remaining portion of the book. Under potassium hydride the statement is made on the authority of Moissan (1903) that KH does not conduct electricity. It may be that no work has been done since 1903 on this particular property of the substance; but this bald statement is misleading especially when it is not in accord with the modern conception of valency, more so when a similar observation of Moissan with respect to LiH has beeen shown to be inaccurate (Gmelins, System Nr. 20, *Lithium*, p. 74).

In Lieferung 2, in which the references are brought up to October 1936, are described the compounds of K with N and O, and with F and Cl including $KClO_2$ and $KClO_3$. The pride of space is of course given to KCl inasmuch as the summary of all the work done on this substance takes up no less than 122 pages.

Lieferung 3, brought up to April 1937, deals with the compounds of K with Br, I, S, Se and Te.

Perhaps one may get impatient with these instalment publications. But the reward of waiting is that one gets an authoritative and documented summary of all the work done up to the date of publication.

M. R. N.

Gmelins Handbuch der anorganischen Chemie. (8 Auflage, System Nummer 27, Magnesium).—[Teil A—Lieferung 1, 1937, pp. 1–156, Price RM. 18·00; Lieferung 2, 1937, pp. 157–372. Price RM. 25·50.] (Verlag Chemie, G.m.b.H., Berlin.)

Both sections deal with the element magnesium as distinguished from its compounds. The occurrence, preparation and manufacture of the element are described in *Lfg.* 1 (brought up to April 1937), while the physical and chemical properties are treated in *Lfg.* 2 (May 1937). The technical process is illustrated with a good diagram, a rare but welcome feature. The subject-matter is handled with the thoroughness characteristic of the Gmelins series. One notes that the main isotopic constituents of magnesium are ^{24}Mg, ^{25}Mg and ^{26}Mg. With regard to the unstable isotopes, ^{23}Mg is produced by the interaction of high-speed deutons and sodium, resulting in the production of "Bineutrons";

$$^{23}_{11}Na + ^{2}_{1}D \rightarrow ^{23}_{12}Mg + ^{2}_{0}n,$$

the new isotope of Mg being a positron emitter. At the other end, ^{27}Mg can be obtained by reacting Al with neutrons:

$$^{27}_{13}Al + ^{1}_{0}n \rightarrow ^{27}_{12}Mg + ^{1}_{1}H.$$

The heavier isotope is a negatron emitter.

Similarly, comprehensive information is also available of analytical methods of estimating Mg. The bromate method given on page 359 requires correction. Evidently, the hypobromite method of Brandis and the bromate method of Christensen have been mixed up.

M. R. N.

Mikroanalytische Nachweise anorganischer Ionen (Microanalytical Detection of Inorganic Ions). By Gerhard Kramer. (Akademische Verlaggesellschaft, M. B. H., Leipzig), 1937. Pp. 35 + 8 Tables. Price RM. 5·6.

The author has collected in a book form important micro-chemical reactions of the common inorganic ions. In all forty-three reactions are given with detailed instructions for carrying them out. The limit of the test, the interference of other ions, the magnification of the crystals are also given. The crystal photographs appended at the end of the book are particularly good.

The reviewer wishes that typographical errors like 'nitrid' for 'nitrit' in *Erklärung zu Tafel* II, Abb. 1 and 'Abb. 5' for Abb. 6 in *Erklärung zu Tafel* VI were avoided. Sulfat and Nitrat have been included under Gesuchtes Element on page VIII.

The book on the whole is well got up and it will be of value for beginners of the subject.

C. SRIKANTIA.

Plant Ecology. By Hildra Drabble. (Edwin Arnold & Co., London, W. 1), 1937. Pp. 136, with 24 photographic illustrations. Price 7*s.* 6*d.* net.

This book is intended as a "readable introduction to the study of Ecology". It is divided into two parts. Part I deals in a simple manner with the nutrition of plants as individuals and their relation with water, and introduces the student to some ecological terms and concepts. Part II deals with plant communities in relation to their habitats and to each other. In this part, a number of typical communities are described and, through them, the interaction of ecological factors is illustrated.

Books on Ecology one generally comes across are either too learned or ponderous for the average undergraduate. In that respect this little book removes a want, but the fact that it deals with only temperate vegetation, especially of Great Britain, makes it of limited use to the student of tropical vegetation. It will, however, be a useful guide to students of Ecology in their study of vegetation. Common English names have been freely used, thus making the book understandable to English readers but at the same time readers not familiar with these common names will find it difficult to visualise the vegetation described. Use of both common and scientific names would add to the usefulness of the book.

P. P.

Chemical Kinetics.—(Actualités' Scientifiques et Industrielles.)

No. 425. *Reactions en Chaines. Theorie des Chaines. Combustion de l'hydrogene.* By M. Prettre. 1936, Pp. 88, Price 18 *fr.*

No. 426. *Introduction a la Cinetique des Reactions Chimiques en Phase gazeuse.* By A. Lalande. 1936, Pp. 44, Price 12 *fr.*

No. 428. *Reactions en Chaines. Etude Cinetique de diverses Reactions de Combustion.* By M. Prettre. 1936, Pp. 78, Price 20 *fr.*

No. 509. *Les Conceptions Actuelles des Mesanisme des Reactions Chimique (Cinetique Chimique). Premiere Partie Generatités, Processus Elementaires.* By M. Letort. 1937, Pp. 58, Price 15 *fr.*

No. 510. *Les conceptions Actuelles de Mechanisme des Reactions Chimiques. (Cinetique Chimique.) Deuxieme Partie. Analyse de la Reaction Globale. Conclusions.* By M. Letort. 1937, Pp. 51, Price 15 *fr.* (Hermann and Cie, Paris.)

The chemist is essentially interested in the final products of a chemical reaction, the composition and yield in which these products are obtained, and the conditions which facilitate the reaction in the required direction. These final reaction equilibria have been studied extensively both from practical and theoretical standpoints, and in particular by the application of thermodynamic methods such as Vant Hoff's Isochore, Nernst's Third Law, etc., so that our present-day knowledge of the subject has reached more or less a high degree of perfection.

However, a study of the actual mechanism of the reactions, the *modus operandi* by which the final products are obtained was, for a long time, left in the background and indeed much in the state to which Vant Hoff and Arrhenius had developed the subject. No serious attempts were made at further elucidation both because an intimate knowledge of the individual properties of the reacting molecules or atoms was required, and also because a study of the transient intermediate products has been always a difficult one. Further, there were but few reactions which were simple enough even for preliminary studies, and attention was therefore largely concentrated on the search for and detailed study of these simplest reactions. The pioneering works of Hinshelwood, Kassel, Lindemann and others in this direction are largely based on kinetic ideas of collision processes between reacting molecules, and the energy distribution in them and between them. These purely statistical theories were soon however found to be insufficient for a complete explanation when more and more detailed studies were made of even these simple reactions, and a new orientation to the ideas regarding the mechanism of chemical reactions was presented in the concept of Chain Reactions, developed largely by Semenoff and his school. The whole subject is still in an evolutionary stage, but many important progresses have been achieved, a knowledge of which it is imperative for all interested in the borderland of chemistry and physics, to possess.

Connected accounts of the rapidly growing literature on this subject are to be found in the well-known books of Hinshelwood (1923), Kassel (1932) and Semenoff (1935). There appears, however, to be no book in the French language, and the monographs cited above are avowedly intended to remove this defect. The last two numbers by M. Letort form a veritable picture of what a clear and lucid presentation of this subject can be and all those acquainted with French, will find themselves carried through a general survey of the subject in easy and pleasant stages. The monographs by M. Prettre are more specialised and deal essentially with the Reaction Chain theory and elucidation on this basis of various combustion reactions.

The whole set form a useful collection of monographs on this subject of chemical kinetics and are well worth their price for a college or a personal library. M. A. G. RAU.

L'oeuvre Astronomique de Gassendi. Par P. Humbert. (Actualités Scientifiques et Industrielles No. 378. Hermann & Cie., Paris), 1936. Pp. 32. Price 8 *francs.*

In this interesting monograph, Prof. Humbert gives an account of the astronomical work of Pierre Gassendi, a famous French mathematician and astronomer of the seventeenth century. Galileo, as is well known, was the first to explore the heavens with the small telescope he made for himself (the simple "Optic tube"). His discoveries gave a great impetus to astronomical observations and in the early years of the telescopic era, Gassendi was one of the most prominent figures in the scientific world. In the first section of the monograph, is given a short sketch of his life. The next section contains a description of the instruments with which he observed, his methods of work, the places of observations and also a brief account of the assistant who collaborated with him. Section III deals with his astronomical observation and various other researches. Like his con-

temporary Scheiner, he made a series of observations of Sun spots and seems to have obtained results of considerable interest.

The Moon, the phenomena of eclipses and occultations, Jupiter and his satellites and the rings of Saturn have all claimed his attention and in collaboration with Pieresc he prepared one of the earliest maps of the moon. Gassendi is perhaps best known as the first observer of a Transit of Mercury across the Sun's disc—having observed at Paris the transit which occurred on 7th November 1631 and which was predicted by Kepler in 1629. His journal contains precise records of observation of auroral display, solar and lunar halos, etc. By his work and correspondence Gassendi appears to have exercised great influence on contemporary scientific thought and the booklet presents an excellent account of the life and work of the great astronomer. T. P. B.

Les Parallaxes Dynamiques des Etoiles Doubles. Par M. D. Barbier. (Actualités Scientifiques et Industrielles No. 348. Hermann & Cie, Paris), 1936. Pp. 31. Price 10 *francs*.

For various investigations on the structure of the sidereal universe, a knowledge of the distances of stars (*i.e.*, their parallaxes) is indispensable. Of the several elements that are required to be known in connection with the system of stars, the parallax is perhaps the most difficult quantity to be determined. It is only for some of the very nearest stars that it has been measured with a reasonable degree of accuracy. For the vast number of stars that are beyond the reach of direct parallax determinations, astronomers have to depend on indirect methods for estimating distances. One such method applicable in the case of binary stars, is based on the assumption that the masses of stars in any specified system are as given by the mass-luminosity law first formulated by Eddington. The reliability of the parallaxes obtained by this method is indicated by the fact, that according to Russell and Moore, the total probable error in a good determination is $\pm$ 28 per cent. of the true parallax.

In the monograph under review, M. D. Barbier of the Marseilles Obervatory gives an interesting resume of the method of determining parallaxes in the case of binary stars whose orbits are known with accuracy as well as those observed over only a small arc. The book opens with a brief historical introduction explaining the principles of the method and dealing with some of the early work on the subject. In the next two sections, the formulæ derived by Russell, Hertzprung and Finsen for the calculation of dynamical parallaxes are described in detail. The last section contains, besides other information of interest, an account of an important investigation on the distribution function of parallaxes. The exposition of the fundamental theorems and results appears to be good. The monograph is written in a clear, readable style and will prove useful to the professional astronomer as well as to the general reader. There is a fairly comprehensive bibliography at the end of the book. T. P. B.

The Naming of Plants. By Vera Higgins. (Chapman & Hall, Ltd., London), 1937. Pp. 103. Price 3*s*. 6*d*.

In India, perhaps more so than at home, the amateur gardener as well as the nursery man finds difficulty with the names of plants. While the Latin or scientific names of nursery plants may, with some study, be gleaned from gardening books, yet in cases in which a plant goes under two or more different names, full information is generally wanting. Popular or common names are confusing, especially in cases of plants introduced from abroad, or in cases where different popular names exist in various vernaculars. Again, a good many Hybrids and varieties of garden plants, such as Dahlias, Croton, Bougainvillea, etc., which are being annually raised in Indian establishments, are being indiscriminately named without regard to whether they are actually new or already existing elsewhere.

The rules issued by the Botanical Congress for regulating the naming of plants are not generally available or known.

Mrs. Higgins' little book is therefore to be welcomed, as it not only gives an interesting insight into the present condition of plant-nomenclature, but also clearly explains the rules and recommendations of the International Botanical Congress.

Her advice that Government Botanical and Horticultural Institutions as well as Horticultural Societies should carefully examine newly named plants, especially of garden origin, and give wide publication to accepted new names, is very important.

G. H. K.

Polymerization and Its Technical Applications.

[*Polymerization and Its Applications in the Fields of Rubber, Synthetic Resins and Petroleum.* By Robert E. Burk, Howard E. Thompson, Archie J. Weith and Ira Williams. (American Chemical Society, Monograph Series, Reinhold Publishing Corporation, 1937, pp. 312, Price $ 7·50.]

THE technical importance of natural synthetic products of high molecular weight has led in recent years to extensive research into every aspect of the processes of polymerization. While the name was originally more or less restricted to reactions in which high molecular substances were formed by a unit molecule capable of self-addition by means of primary valencies, the concept of polymerization has now been extended, for reasons elaborated by Carothers,[1] to any process of aggregation by condensation. Carothers defined polymerization as a chemical combination of a number of similar molecules to a single molecule, the essential feature of the phenomenon being the functional ability of the reagents or monomers to undergo indefinitely continuous condensation to form abnormally large molecules. In the book under review attention has been drawn to the desirability of retaining certain classifications within this very wide definition and of excluding from it the loose and impermanent types of chemical union such as association phenomena.

Polymerization has been regarded by the authors as one of those subjects which are intermediate between the theoretical fields in which the intrinsic interest of fundamental problems (the Raman effect, heavy water, etc.) lead to vigorous research and the industrial fields in which practical difficulties stimulate investigations of methods for their solution. It would perhaps be truer to say that polymerization is one of the chemical processes which are alike of profound interest to the academic chemist and of wide practical utility in numerous manufacturing operations; and the criticism that it has not received systematic encouragement at the hands of industrial concerns is not altogether justified. The extent to which organisations such as the I. G. Farbenindustrie have furthered and subsidized fundamental investigations with no immediate or obvious bearing in industry is remarkable. Two examples from the present book itself are the X-ray researches of Mark and Meyer of the I. G. Farbenindustrie on the structure of high polymers and the work of Carothers of E. I. du Pont de Nemours and Co., on many theoretical aspects of addition and condensation polymerization.

Following reviews of the general features of polymerization, the relation between molecular structure and the rate of polymerization, catalysis and polymerization, the mechanism of polymerization reactions and the structure of polymers in respect of the liquid state, the book deals with the applications of polymerization processes in three important industries—rubber, synthetic resins and petroleum. The structural factors that may be said to predispose an organic compound to union with itself or with closely similar molecules have been enumerated as unsaturation, conjugation of unsaturated linkages, alkyl substitution, certain cyclic systems, halogen substitution, and the carboxyl group; each has been dealt with in detail with regard to examples of polymerizing substances, the products formed and the factors governing the phenomena. Since our knowledge of the part played by catalysts in polymerization is largely empirical, the chapter on catalysis consists of a tabular statement, running into 57 pages, of polymerizing substances and of reagents that catalyse each reaction, together with references to the relevant literature. The material thus collected and correlated should prove invaluable to the research worker in search of a suitable catalyst for a specific purpose. The precise rôle of catalysis in polymerization has remained obscure on account of the inherent complexities of the problem, but it has been noted that in two cases at least (the polymerization of ethylene, propylene and butylenes by phosphoric acid and the polymerization of diolefines by means of metallic sodium) the course of the reactions involved has been elucidated.

The treatment of the mechanism of polymerization from kinetic considerations has been limited by various difficulties — the sensitivity of polymerization reactions to catalysis, the multiplicity of the resultant products, the possibility (one should rather say the certainty) of the existence of chain reactions, and the mystery of the liquid state involved in many polymerizing systems. After a general review of our present

[1] *Chem. Rev.*, 1931, **8**, 354; *Faraday Soc. Symposium on Polymerization*, 1935.

knowledge of each of these factors, the mechanism of polymerization has been discussed fully in the individual cases of the acetylenes, the olefines and the diolefines, the concluding part of the chapter, as well as chapter V being devoted to polymerization in liquid systems.

The chapters concerned with the part played by polymerization in the rubber, synthetic resin and petroleum industries are of uniform excellence. Every feature is clearly and adequately treated and the one defect of the earlier chapters — a tendency to sacrifice clarity for comprehensive cataloguing of published data is notably absent. While the study of the chemical structure of the technically valuable polymers is rendered a matter of the utmost complexity by reason of the high molecular weights and the nature of the substances as a mixture of closely related compounds rather than chemical individuals, the chemical and X-ray evidence has been extensively surveyed. Polymerization in the petroleum field is of necessity restricted to technical applications, such as the refining of petroleum products by selective polymerization, the use of inhibitors for the suppression of oxidation and consequent polymerization, the manufacture of artificial asphalt and the synthesis of motor fuels from gas.

To the general chemist who wishes to have an introduction to a new and rapidly developing branch of chemical technology, the usefulness of the book would be increased by an expansion of the chapter on the relation between molecular structure and polymerization, and more particularly by the inclusion of structural formulæ in at least a few of the more important of the numerous instances where the name of a compound does not lead to an immediate mental picture of its constitution. In discussing isoprene and its bearing on polymerization problems,[2] more pointed attention might have been drawn to the isoprene basis of the structure of many natural products. A very minor omission, which happens to be of interest to the reviewer, is the application of synthetic resins in the manufacture of anti-crease fabrics.

K. VENKATARAMAN.

[2] *Cf.* Whitby, *Trans. Inst. Rubber Industry*, 1929, **5**, 185; 1930, **6**, 40.

ASTRONOMICAL NOTES.

Planets during February 1938.—Mercury will be a morning star during the month; on February 17 it will be in conjunction with Jupiter, the distance between the two planets at the time being 1° 23′. Mars will continue to be visible in the western sky in the early part of the night. Jupiter after passing conjunction with the Sun on January 29, becomes a morning star and can be seen, during the latter half of the month, as a bright object rising about three-quarters of an hour before sunrise. Saturn is situated in the same direction as Mars and on February 3, the two plantets will closely approach each other to an angular distance of about 2°. Uranus is in the constellation Aries and will be in conjunction with the Moon on February 7.

The Minor Planet Eros.—The physical nature of this well-known asteroid is discussed by F. Watson Jr. in *Harvard Circular* 419. From the short period light variations he deduces that the axis of rotation is pointing towards the direction indicated by the point on the celestial sphere whose co-ordinates are R.A. $21^h\ 4^m$ Dec. 51° N. The rotation is found to be retrograde. The observations of Finsen and Van den Bos at Johannesburgh in February 1931 appear to show that the asteroid is probably a long irregular solid about 35 kilometres long and 11 kilometres in diameter, and that the reflectivity is about 15 per cent. But the results of the work of Zessewitsch of the Leningrad Institute are not in agreement with these conclusions. His discussion seems to indicate that the direction of Eros' rotation does not remain constant, but is subject to considerable changes. The observations that will be made during the opposition of 1938 are likely to throw further light on the subject.

The Geological Survey of India Laboratory.

Organisation.

THE headquarters office of the Geological Survey of India is a four storey building built in 1897 and is situated behind the Indian Museum in Calcutta. The general disposition of the building is as follows :—

Ground floor : godowns and clerks' offices,
First floor : senior officers' rooms ;
Second floor : Director's room, library and map room ;
Third floor : laboratory, darwing office and junior officers' room.

The headquarters staff working immediately under the Director consists of the Petrologist, Assistant Director, Palæontologist and Chemist.

The Assistant Director controls (*a*) the clerical staff under the Chief Clerk, (*b*) the Library and (*c*) the Drawing Office, which is in charge of the Artist. The Assistant Director is also in charge of the publication of the *Memoirs*, *Records* and *Palæontologia Indica* published by the Department.

The Palæontologist, assisted by a Field Collector and Museum Assistant, is repsonsible for the large and steadily increasing collections of fossils which are constantly receiving the attention of the Department. He also advises on the arrangement of the Siwalik and Invertebrate galleries in the Indian Museum.

In the past the Laboratory has been in charge of the Petrologist, but it is intended shortly to divide it into two sections, the Chemist to have control of his own section. Working under the Petrologist is the Curator, who attends to the rock, mineral, economic and meteorite galleries in the Museum, looks after the upkeep of the office building, and the general routine of the Laboratory. In addition, two Field Collectors and three Museum Assistants attend to the varied work going through the Laboratory.

The Laboratory.

The work of the Laboratory is divided into two sections, petrological and chemical.

Petrological Laboratory.—In the Petrologist's room are stored the majority of the petrological and field instruments. These include about 40 microscopes with innumerable accessories, various types of refractometers and goniometers, some 20 cameras both for microscope and field use, aneroids, clinometers, etc. In addition, there are other instruments such as electrometers, spectroscopes, etc. The equipment is very complete, the only serious shortage being a photographic spectrometer and an X-ray equipment.

The Geological Survey makes no charge for the determination of specimens, which are constantly being submitted from all over India, but merely stipulates that the locality from which the specimen was obtained should be given. This is for the

Departmental records and is kept confidential, if so desired. As a rule, specimens from outsiders are only determined qualitatively, most of the quantitative analytical work being reserved for Departmental specimens. Between 500 and 800 extra departmental specimens are examined annually. Nearly all specimens are determined by a Museum Assistant and checked by the Petrologist. Most of the Petrologist's time is devoted to special petrological work and to advising on economic questions, on which a large number of enquiries are received, and are

constantly increasing in pace with expanding interest in the mineral industry of India.

Besides the usual thin-section determination, opaque minerals are also examined under reflected light, for which there is an excellent equipment. The making of thin-sections and polished sections is done mechanically on revolving laps. The polished section technique is up-to-date.

The microphotographic apparatus is in the Petrologist's room. Here also there is a collection of some 25,000 thin-sections of rocks from all over India and from other countries. In addition, stored in the Museum, are some 50,000 rock specimens, the collections of Officers of the Department over the course of eighty years.

Chemical Laboratory.—The staff of this laboratory consists of the Chemist in charge, Assistant Chemist and Laboratory Attendant, with menials shared with the Petrological side. The equipment is more or less complete. In addition to the usual analyses, dry assays are done when necessary, using gas-fired and electric furnaces. A large stock of apparatus and reagents has to be kept on hand. The apparatus includes a calorimeter for coal determination, small electromagnetic separator, electric ovens and all the usual accompaniments of a chemical laboratory.

The Drawing Office.

The Drawing Office is equipped for the production of the following classes of work:

(1) *Photography.*—The development and printing of Officers' negatives, photo-copying of specimens (rocks, fossils, meteorites, minerals, etc.), micro-photography of rock sections and minerals, map-copying by photography, etc., are undertaken. There are arrangements for direct photo-micrography with a vertical camera and enlarging lens (by daylight or artificial light), as well as with vertical and horizontal photographing apparatus with artificial lighting.

(2) *Map Drawing, Copying and Colouring.*—Hand drawing, copying and colouring of geological maps, sections and diagrams, pantograph reductions and tracing (on glass tracing tables illuminated from below) of maps, preparation of original maps for reproduction, drawing text-figures and line plates for publications, and fossil drawings (in wash and line) are executed. All the original geological maps of the department and the topographic sheets that are used in the field and for fair-copying, as well as the maps published for sale by the Department, are classified and stored in the map-room in the Drawing Office.

(3) *Reproduction.*—The reproduction of text-figures and plates for the publications of the Department (*Records*, *Memoirs* and *Palæontologia Indica*) by halftone, line and lithographic processes, in monochrome and in colours, and the printing of these plates, is carried out. There is a fully equipped process-engraving and lithographic plant with camera, screens, stands, copying lamps, etching, finishing and mounting apparatus and machinery; also a platen printing press with cylindrical inking, with type and accessories for printing halftone and line plates and type jobs of the Department. There are also three hand presses (two being transfer presses) for litho printing. Fine-screen (175-line and 200-line) halftone work is done for the reproduction of photographs for plates for publications.

The Library.

Almost the whole of the third floor is occupied by the extremely fine library of which Officers of the Department feel justly proud. It contains approximately 80,000 books and papers, and is now being re-catalogued according to a more modern system.

The Godown.

Nearly 200 tents are stored in the godown, and are in the charge of the Petrologist's Department. A carpenter and a polish mistri, under the Curator, are also located here.

ARCHÆOLOGICAL NOTES.

Age of Ukkal and its Viṣṇu Temple.

THE village of Ukkal[1] is situated one mile to the east of Kūḷampandal[2] which is another village about six miles to the south of Māmaṇḍūr near Conjeevaram (Kāñci). Dr. Hultzsch, who visited the place in 1893, describes the ancient Viṣṇu temple there thus :—" Of the shrine itself, only the lower portions remain standing and the maṇḍapa in front of the shrine threatens to collapse at any moment. The bases of the shrine and of the maṇḍapa bear 17 inscriptions. Of these, 14 were copied and published.[3] The remaining three were omitted as they are incomplete."

Of the 14 inscriptions copied, two, the earliest in the list, belong to the reign of the late Pallava king Kampavarman. The first one[4] inscribed on the south wall of the shrine, is dated the tenth year of Kampavarman's reign and records that one Saḍaiyan entrusted four hundred kāḍi of paddy with the Sabhā at Ukkal who pledged themselves to feed two Brahmins daily with the interest which amounted to 100 kāḍi per annum. The other inscription[5] found on the same wall is dated the fifteenth year of Kampavarman's rule and states that the Sabhā of Ukkal received 1000 kāḍi of paddy from the same Saḍaiyan and agreed to collect 500 kāḍi yearly as interest on the 1000 kāḍi and hand it over to the annual committee (Saṁvatsara Vāriya Perumakkaḷ).

Excepting the above two inscriptions, the remaining twelve belong to the Cōḷa period. The existence of Kampavarman's inscriptions on the wall of the Viṣṇu temple enables us to infer that the village and the shrine are older than the time of the earliest Cōḷa king mentioned in the inscriptions from the same temple. However, Kampavarman's inscriptions do not tell us who the builder of the temple was. On the other hand, it is the Cōḷa epigraphy of the place that throws light on the antiquity of both the village and the temple.

Inscription No. 1,[6] dated the twenty-third year of the Cōḷa king Rājakēśarivarman, speaks of the other ancient names of the village of Ukkal—"Śivacūḍāmaṇimaṅgalam" and " Aparājitacaturvēdimaṅgalam," which are undoubtedly Pallava names. We know that Rājasimha bore the surname 'Śivacūḍāmaṇi'[7] and that Aparājita was the last Pallava king. The village must have received its name Śivacūḍāmaṇimaṅgalam after Rājasimha in his time and then Aparājitacaturvēdimaṅgalam after Aparājita in the latter's regime. The name Śivacūḍāmaṇimaṅgalam takes the age of the village as far back as the seventh century A.D. Another name of the village referred to in the Cōḷa inscriptions is Śrī Vikramābharaṇacaturvēdimaṅgalam, which must have been given after some Cōḷa king subsequent to the Cōḷa conquest of Toṇḍaimaṇḍalam.

Regarding the origin of the temple, the Cōḷa epigraphy tells us that its ancient name was Bhuvanimāṇikka Viṣṇugṛham. Dr. Hultzsch has admitted that Bhuvanimāṇikka " The ruby of the world " might have been a *biruda* of the unknown founder of the temple. But it may be observed that the Pallava king Nṛpatungavarman had a queen by name Prithivīmāṇikkam,[8] and that a measure was also known after the same queen.[9] So far as the meaning of the two names 'Bhuvanimāṇikkam' and 'Prithivīmāṇikkam' goes, there is absolutely no difference. Hence it may be suggested that it is not unlikely that this queen was the builder of the Viṣṇu temple at Ukkal. This tentative inference may be well substantiated if any of the fragmentary inscriptions on its walls could be assigned to the time of Nṛpatunga.[10] And a proper and careful study of the architectural features of the ruined temple may yield additional support towards the dating of this temple.

C. MINAKSHI.

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[1] *Madras Survey Map of the Arcot Taluk.*

[2] *Ibid.*

[3] *S.I.I.*, **3**, Part I, p. 1, *et seq.*

[4] *Ibid.*, p. 13.

[5] *Ibid.*, p. 9.

[6] *S.I.I.*, **3**, Pt. I, p. 2.

[7] See Nos. 24 and 31 in *S.I.I.*, **1**, where this surname of Rājasimha occurs.

[8] Sewell's *List of Ant.*, **2**, p. 30.

[9] *Mad. Ep. Rep.*, 1905, 460 and 461.

[10] *Ibid.*, 1902, 412. A damaged inscription which belongs to the time of Gaudagopala.

CENTENARIES

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Woodward, Samuel (1790–1838)

SAMUEL WOODWARD, amateur geologist and antiquary, was born at Norwick, October 3, 1790. His father, who was a weaver, died at the age of 33, before Samuel was five years old. Having attended a private school for two years, he went to work with a shawl-weaver. But so desirous was Samuel to learn that he devoted every spare moment to study and read with eagerness every book which came within his reach. In 1804, he joined the service of another local weaver, Mr. Herring, who was wealthy and owned a library. During the next twelve years, when he was working under Herring, Samuel made the fullest possible use of this library. After Herring closed down his business, Samuel worked for six years in the the Northwick Union Fire Office and later entered the Banking house of Messrs. Gurney's & Co., where he remained until his death.

His Hobby

One of the first geological puzzles Samuel endeavoured to solve, was a mass of flint containing *Ananchytes* which he had noticed on a cottage mantle-piece. And one of the books which first excited his attention and perhaps directed it to antiquarian and geological studies was Kerstegan's *Restitution of decayed intelligence in antiquities concerning the most noble and renowned English nation* (1605). Thereafter he commenced to form the extensive collection of fossils and antiquities, which are now deposited in the Norwick museum.

His Publications

In 1824, he made his first communication to the Society of Antiquaries. It consisted of a series of maps and plans of ancient Norfolk. In 1825, he had already completed a *Sketch of the Norwich crag deposit* and his *Remarks on the geology of the county of Norfolk.* His *Geology of Norfolk*, which came out in 1833, contained many accurate drawings of fossils. His *History and antiquities of Norwich castle* was posthumously published in 1847. So also was the case with his *Norfolk topographer's manual* (1842). The number of Woodward's publication reaches 30. Some of them appeared in the *Magazine of natural history* and the *Philosophical magazine.*

His End

His devotion to science and his continuing (after the laborious duties of the day) to spend hours in study undermined his health and he fell a victim to diabetes. Samuel died January 14, 1838.

Morley, Edward Williams (1838–1923)

EDWARD WILLIAMS MORLEY, the scientist, was born in Newark, January 29, 1838. During his early childhood, he suffered much from ill-health. For this reason his early education was undertaken by his father and he was taught at home until the age of nineteen. He learned to read before he was three years old, began Latin at six and Greek at eleven. He found among his father's books one entitled *Conversations on chemistry* which fascinated him more than the *Arabian nights* which stood near it on the same shelf. When twelve years old, he spent all his pocket money on chemical experiments. When he was about fourteen, he mastered a text-book of chemistry by Benjamin Silliman. He graduated from Williams College in 1860 and from Andover Theological Seminary in 1864. He spent a few years as minister.

In 1869, he became Professor of Natural History and Chemistry in Western Reserve College. From 1873 to 1888, he also held jointly the professorship of chemistry in the Cleveland Medical College. He was one of the first to introduce practical chemistry into the curriculum. He found the money for the apparatus for his researches by doing some routine analysis for the local firms.

His Work on Astronomy

From 1860 to 1869, Morley was attracted to astronomy by the inspiration of Professor Albert Hopkins. He mounted a transit instrument, constructed a chronograph and made the first accurate determination of

the latitude of the college laboratory. This was the subject of his first paper, which was read before the American Association for the Advancement of Science in 1866. Laplace's *Mecanique celeste* fascinated him during this period.

Loomis-Morley Hypothesis

His main interest was however in chemistry. In 1878, his attention was directed to reported variations in the proportion of oxygen in the atmosphere. For three years he pursued the subject. He made analysis of the amount of oxygen in the air on 110 consecutive days. This corroborated the Loomis-Morley hypothesis according to which the deficiency of oxygen was supposed to occur at times of high barometric pressure, due to downward currents bringing air from high altitudes.

Composition of Water

The outstanding labour of his life is his work on the density of oxygen and hydrogen and the ratio in which they combine. He was occupied with this investigation for about twelve years and the results were published in 1895, as Smithsonian contribution to Knowledge, No. 980, and also appeared in German in the *Zeitschrift fur physikalische chemie*. This research placed him at the very first rank of scientists. It is a remarkable tribute to his accuracy that even now the accepted values of these quantities are practically identical with those found by him.

His Work in Physics

Morley was as eminent a physicist as chemist. His characteristic for precision is exhibited by his early papers on *Ruling on glass* and the *Probable error of micrometric measurements*. His joint work with Michaelson on the relative motion of the earth and the ether and his later work on the drift of the ether in collaboration with D. C. Miller are well known.

His Honours

Morley contributed about fifty-five papers. He became President of the American Association for the Advancement of Science in 1895 and of the American Chemical Society in 1899. He was awarded the Sir Humphrey Davy Medal by the Royal Society (1907), the Elliot Creson Medal of the Franklin Institute (1912) and the Willard Gibbs Medal by the American Chemical Society (1917). In 1912, he was Honorary President of the Eighth International Congress of Applied Chemistry. He received honorary degrees from several Universities and was an honorary member of several learned bodies.

His Library

Very early in his career, Morley realised the importance of books in enabling one to keep abreast of the work being done in one's science. Since his college was unable to purchase books for him, he began to collect a library of the principal chemical periodicals and soon he had the biggest collection of them in the whole of America. On his retirement in 1906, his college purchased the library from him.

Morley died after an operation, February 24, 1923.

Eros Approaching.

ASTRONOMERS are beginning to turn their telescopes toward Eros, the small planet which is one of the earth's nearest neighbours in the Solar System. In January this tiny celestial visitor will come within 20,000,000 miles of the earth.

Eros is peculiar in that it, instead of being rounded, seems to resemble a gigantic slab of stone some 22 miles long by only about seven miles in width and thickness. This elongated world keeps tumbling over and over in space like an athlete turning handsprings.

So reports Fletcher Watson Jr., of the Harvard Observatory, in studies which provide an instance of how modern astronomy manages to learn much about an object almost too faint to be seen at all. The orbit of Eros brings it reasonably close to the earth every few years. When this happens the brightness of the small world is found to vary in a cycle of about five hours believed to be due to its rotation. Studying all recorded observations of these light changes, Mr. Watson deduces the elongated shape and other probable characteristics.

Eros apparently is made of some brownish or yellowish rock or similar substance, is about the same all the way through and revolves around an axis perpendicular to its greatest length, like a dumb-bell tumbling end over end.—*The Sky*, 1937, **2**, No. 11, 27.

RESEARCH ITEMS.

On Bounded Power Series.—Rogosinski (*Comp. Math.*, 5, pp. 67–106) has obtained some interesting results concerning the distribution of values of a function bounded in the unit circle. A few years ago Nevanlinna had discussed the existence of a function $f(z)$ analytic and $\leqslant 1$ in absolute value in the unit circle which takes values $\{w_k\}$ at a given sequence of points $\{z_k\}$. Now Rogosinski has considered the case when $w_k = w$ for all k, and has obtained results concerning this particular case in greater detail. His results are the following :—

Let E denote the class of functions $f(z) = az + \beta z^2 + \cdots$ analytic and < 1 in $|z| < 1$, and $E_{|a|}$ those $f(z)$ with fixed $|a|$. When $f'(0) \geqslant 0$, let the same classes be represented by E_+, and E_a. Let $\{t_k\}$ be a sequence of points in the unit circle such that $0 < t_k \leqslant t_{k+1}$. Suppose $f(z)$ is to take the common value w at the points of this sequence. If a is fixed then can w be arbitrary or is to be restricted ? This is the problem that he solves. The proof he gives is extremely simple and makes use of only Schwarz's lemma and Lindlöf's principle. He has divided his work into two parts the first of which has appeared now. This part deals with the case when $f(z)$ need not be restricted to take the value w *only* at the point of the sequence. In the second part, which is to appear in the same journal, he considers the latter—the more interesting case. Some of his results are given below:

(1) If $w = 0$. Then $a \leqslant \prod_k |t_k| = P_0$. From this it is obvious that if the density of the points of the sequence is too great, *i.e.*, $\prod_k |t_k| = 0$, $[k = 1, \cdots \infty]$, then the function should be identically zero.

(2) for $|z| \leqslant r < 1$,

$$\left| \frac{f(z)}{z \prod_k \frac{z - t_k}{1 - t_k z}} \right| \leqslant \underset{|z| = r}{\text{Max}} \left| \frac{z - \frac{a}{P_0}}{z \frac{a}{P_0} - 1} \right| = \frac{r + \frac{a}{P_0}}{1 + \frac{ra}{P_0}}$$

with the corresponding inequality for the minimum. (A slightly more precise result is also given by the author.)

(3) For the class E_a, if the function takes the value w [it may also take the value at other points also] at $\{t_k\}$, then the following inequality is to be satisfied and *vice versa*

$$\left| a \frac{1 - |w|^2}{|w|} - \Sigma \frac{1 - |t_k|^2}{t_k} \right| \leqslant \frac{P_0}{|w|} - \frac{|w|}{P_0}.$$

This is the best possible constant.

(4) Every function belonging to E_a is for $\frac{2z}{1 + |z|^2} \leqslant a$ is star-formed (*stern-formig*) with the centre of the star at the origin. This is also the best possible constant.

Various other bounds for higher differential coefficients as well as extensions to functions meromorphic in the unit circle as well as extensions to the family of functions, a finite number of differential coefficients (at the origin) of which are given are also considered by the author.

K. V. I.

* * *

Mechanism of the Dehydration of Zeolites.—Milligan and Harry B. Weiser (*J. Phys. Chem.*, 1937, **41**, 1029) have shown by studies of the dehydration isobar and X-radiogram that calcium sulphate hemihydrate or plaster of Paris is a definite chemical hydrate and not a zeolite as believed from previous investigations. The manner in which water is bound in zeolites has been explained by early workers by the following three proposed theories: (*a*) Solid solution theory, (*b*) "Vagabond water" theory, (*c*) Adsorption theory. Study of the several zeolites by the present authors by the above two methods reveals the fact that some are definite hydrates, some are mixtures of two hydrates and some others are not hydrates at all, but hold water by adsorption forces within channels in the lattice. Obviously the binding forces differ from zeolite to zeolite, some hold water by definite chemical forces and others by adsorption forces. Since some zeolites are definite hydrates, and some are not, the authors believe that there is nothing to be gained by the use of the expression " zeolitic water ".

K. S. Rao.

* * *

Effect of Temperature on Mitochondria.—R. C. MacCardle (*Journ. Morph.*, December 1937, 61, No. 3) has studied the effect of heat on the mitochondria of the liver cells of *Fundulus* and *Carassius*. The fishes were subjected to temperatures varying from 0° to 60° C. and the livers fixed cytologically to show the effects of temperature on the mitochondria as well as other cell constituents. The mitochondria vesiculate, fragment, globulate and dissolve after subjection to temperatures of about 37° to 42° C. The Golgi apparatus becomes swollen, breaks into smaller bodies which migrate to the periphery and then dissolves. Fat increases in amount. The vacuoles increase in number.

* * *

Effect of X-Rays on Chromosomes.—Fresh light on the effect of X-rays on chromosomes during the first meiotic division is thrown by M. J. D. White (*Proc. Roy. Soc. Lond.*, Ser. B, November 1937, **124**, No. 835) who, working on three species of Orthoptera, has shown that X-rays do not affect the Prophase chromosomes, *i.e.*, so long as there is a nuclear membrane, which therefore probably acts as a protecting structure. Once the nuclear membrane disappears and the chromosomes are free in the cytoplasm, the latter are affected by the X-rays with the result that at first an alteration in physical consistency and later a fragmentation of the chromosomes occurs. It is suggested by the author that the disintegrating effect is due to the production of an enzymatic substance in the cytoplasm which acts on the chromosomes freely placed in it. It is also shown that " the substance, whatever its nature, is not produced immediately after irradiation but developes gradually " till its destructive effect reaches a maximum after which time the substance is destroyed or prevented from acting.

Geography and History of Millets.*

AN extremely interesting and informative contribution on the geography and history of cultivated plants has recently been published. Dr. Werth has used the spread of human civilization and culture as a guide in his studies on the origin and spread of cultivation of millets. This article is of special interest to India as it deals with the Millets common to India and the part India has played in their spread.

The author divides his work into two parts, *viz.*, (1) the European millets—(*Panicum miliaceum* and *Setaria italica*) and (2) the Non-European millets; or according to climates into: (1) Temperate and sub-temperate, and (2) Tropical sub-tropical millets.

The millets that are dealt with in this paper are:—

ANDROPOGONÆ.—*Andropogon sorghum.*

PANICEÆ—*P. miliaceum*; *P. sanguinale*; *P. crusgalli*, vars. *frumentaceum* and *colonum*; *P. miliare*; *Setaria italica*; *Paspalum scrobiculatum* (*frumentaceum*); *Pennisetum typhoideum.*

CHLORIDEÆ.—*Eleusine coracana.*

FESTUCEÆ.—*Eragratis abysinica*
also *Coix lacrima* Jobi and *Phalaris canariensis.*

P. miliaceum and Setaria italica.—The grains of these millets are distinguished by the high glanz in *miliaceum* and the matt in *setaria* and in the hulled stage the embryo of *setaria* is longish, narrow and occupies nearly two-thirds of the grain-length while in *miliaceum* it covers only about half. The cultivation of these millets spreads over Europe (especially S. Russia), India, China and Japan. It is more intensively cultivated in China and Japan than in India. Körnicke sought for the home of these millets in the Northern Frontiers of India, while Becker-Dillingen placed their home in the regions further South-East on the ground that this formed the staple food of the earlier inhabitants in various countries before the appearance of the Indo-Germanic race. The words for 'bread' commonly applied in India, Greece, Iberia and other lands are closely related. The millets have not been found in the ancient Egyptian tombs but evidence exists as to their having existed in Assyria and in China (as early as 2700 B.C.). In Europe their cultivation was mostly confined, in early times, to the Balkan Peninsula and Italy. At present they are largely cultivated in Central Asia (Kirgistan, Turkestan, Trans-Caucasia, Migrelien Imerien, Gurien), and S. Russia, from the Caspian Sea to the mouth of the Danube. In India they are of little importance. After consideration of the various theories of Vavilov, Schiemann, etc., it is concluded that the probable spread of these two millets started from a broad girdle in N. China, through Central Asia, South Russia into Middle Europe.

P. sanguinale.—Körnicke is of opinion that this millet is probably the most recent to be brought under cultivation since the cultivated variety can hardly be distinguished from the wild one. The Slavic nations were the greatest cultivators of this millet and still are. 'The centre of gravity' of the cultivation of this plant lies towards the South-East of Europe. It occurs wild as a weed in the warmer parts of both hemispheres and is rare in Germany and South-Baltics. Its extraordinarily close relationship to *crusgalli* shifts the 'centre of gravity' of its cultivation still further South-East, somewhere to the area of the great Indo-Germanic volk bridge, "Vorderasiatisch-Dinarisch" races and thereby renders it possible to hazard a guess regarding the probable origin of the culture of *P. crusgalli* (India). In Meyer's dictionary 'blut hirse' is described as being 'probably of Indian origin'.

P. crusgalli and Related Varieties.—This common weed is found in the temperate and warm zones of both hemispheres particularly in the Northern. It is widely distributed in the tropics and is cultivated as a fodder and sometimes as a grain crop. According to Hackel, the variety *P. frumentaceum* Roxb. is known in India as the 'poor man's millet' and cultivated for its grain. A variety or subspecies of *crusgalli* is *P. colonum* and is grown in the warm regions of the globe especially in India. This millet was found in the tombs of the Egyptian mummies of the Jungstein age. In Japan, another panicum (Hie) along with *crusgalli* is cultivated. In China, *crusgalli* is cultivated as a compensating or rescue crop when the paddy crop fails. Its cultivation is known in Manchuria, Dutch Indies, etc. The cultivation of this millet appears to have advanced from India (North-East) through Ethiopian East Africa and from there to Old Egypt. Perhaps, in this species we have the southern counterpart to *P. sanguinale* of the "Vorderasiatisch-Dinarisch" races.

Panicum miliare Lamk.—This variety is grown on soils too poor even for *E. coracana* to grow.

Paspalum scrobiculatum L.—Cultivated as grain and fodder crop in S. Asia including India, China Japan and more recently in America. This species thrives even in very poor soils. According to Becker-Dillingen, five varieties are differentiated in India, *viz.*, *Pouroun-varagou*, *Doupoule-varagou*, *Kourou-varagou*, *Setoukejitsan-varagou* and *Ola-varagou.*

Two crops can be raised in a year. This forms a regular rotation crop with Ragi, *E. coracana* and *P. miliare.* Probably this and the other smaller millets are native to India.

Andropogon sorghum.—The cultivation of this plant is known from a long time in India, China and also Africa. Hackel is of opinion that this plant is native to Africa. It is supposed to have arisen from *Sorghum halepensis* Brot. as an annual plant. It was introduced into N. America in 1840 under the name *S. halepense sudanense* (Sudan grass). A number of varieties of this are known. At present the cultivation of this millet spreads over Upper Egypt, Palestine, Vorderasien (*i.e.*, Persia, Mesopotamia, Arabia, Afghanistan and the Baikal Provinces) and India. There is no Sanskrit name for sorghum. In China it was introduced in the fourth century A.D. and is cultivated under the name Kauliang over the whole of the Middle West and North China. It is most

* Werth, E., "Zur Geographie and Geschichte der Hirsen (Zur Geographie und Geschichte der Kulturpflanzen und Haustiere XIII)," *Angewandte Botanik*, 1937, **19**, Pt. 1, 42–88.

intensively cultivated in North China but is completely absent in the great Southern rice-growing districts. It forms the staple food-crop for many millions of the Chinese and taking India and China together, for over three-fourths milliard people. It is cultivated as a summer crop both in China and in India. It is grown only to a small extent in Middle Japan and in the Dutch Indies it is of no importance at all. In Central Asia, especially in the oasis of Chiva, it is the most important crop. In Europe it is grown in Rumania, Hungary, etc.

In Africa it is not only a food-crop but is largely used by the natives in brewing beer. It is very much cultivated in Abyssinia and in the Negroid Africa.

Pennisetum typhoideum.—In many regions of Africa this forms the favourite agricultural plant. It is also an important crop plant in S. Arabia and in India. Körnicke is of opinion that this plant is native to Africa. The importance attached to this as a food-crop in Africa and the want of a Sanskrit name probably influenced him to place the home of this plant in that Continent. The name for this crop in East Africa is the same as in India, *viz.*, Bajira. The natives of Africa call it Mawele and not Bajira. According to Hackel, "Native country unknown, probably Africa". According to the Jewish prophet Hesekiel (600–571 B.C.), this was known in Babylonia as 'Dochan'. This millet is completely unknown in the lands East of Suez, so the spread of this crop from Africa to India (or the other way) must lie in some other zone. It is cultivated in Africa from Senagambia to Abyssinia, from Algiers, Tunis, to the Mozambique. In Asia it is confined to S. Arabia and India.

As to the history of this millet very little is known. It is not mentioned with any certainty by the old Greek and Latin authors. The oldest reference to it is from Babylonia. The name 'Dochan' in various modified forms is used today in Arabia. Thus, Durra (general name for *A. sorghum*), Dorah, Dochan, Duchn all belong to the same group and probably mean no more than the general term 'millet'.

According to Leck, Pennisetum is polyphyletic in origin, and the following wild forms probably formed the parental types :—

	Intermediate Forms
Pennisetum perrottetii (Klotzsch) K. Schum (Senegambia)	3
P. mollissimum. Hochst. (Egyptian Sudan)	5
P. violaceum (Lamk.) Rich. (Senegambia, Guinea)	1
P. versicolor (Schrad.) (Senegambia, East Africa)	1
P. adœnse (Hochst.) Steud. intermediate forms over *Gymnothrix* ..	3
P. gymnothrix (Al. Br.) K. Schum (Egyptian Sudan, Kordofan) cultivated form of *P. adœnse.*	

Other forms are considered as hybrids and some as reduced forms. To these tertiary forms belong the Indian varieties (*P. spicatum pulkenetii*).

The author having distributed the 32 forms of Leck to their proper places finds that the cultivation of this millet is mainly confined to India and Africa. The greatest concentration of varieties is found in the Egyptian Sudan, in the provinces of the 'dark-skinned Hemetics' (Ethiopian) in the West and North-West highlands of Abyssinia (one of the centres of origin of cultivated plants). Doubtless here lies the origin of Pennisetum for Africa.

According to Leck, the culture of Pennisetum spread from Africa to India and the spread of this particular millet seems, somehow, to have taken the opposite direction to that established for other civilizations. Probably the Indian Pennisetums can be traced back to some wild Pennisetums of India itself. Even as the African Pennisetums are, to a great extent, derived from the wild varieties native to Africa.

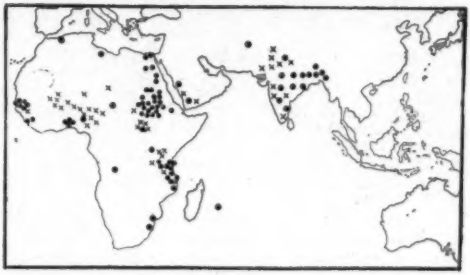


Fig. 1.

Distribution and frequency of varieties of Pennisetum.
... According to Leck.
xxx According to other authors.

E. coracana.—The wild form of this plant is *E. indica* from which it can be distinguished only by the seeds and also the capacity to hold on the seeds in the panicle.

Eleusine indica is spread over the whole of the warmer parts of the earth in both hemispheres. It commonly occurs as a weed with *coracana* and other cultivated varieties. De Candolle and also Becker-Dillingen consider this plant native to India.

Coracana is cultivated over the whole earth except in the extreme Northern and Southern regions. In Africa this is known as Uimbi. In Abyssinia, a white and a dark variety are known. The Sanskrit name for this is Raga, Hindustani Raggi (Raghee), in S. India, Ragi, in N. India, Mandua, and in inner Africa, Murwa. The name employed in Africa is really Mæle, Mawele, etc., for the Bantu Negroes can hardly pronounce a pure 'R'. In Abyssinia it is called Dagussa. and in Arabia, Telebun. The name Korakan according to Körnicke, comes from Ceylon and is derived from the Tamil name 'Kora'.

The largest cultivation of this plant is in India and Africa, and any one of them may be the home of the millet. Körnicke distinguishes two forms : *E. coracana* and *E. stricta.* Both forms are cultivated in India—*stricta* more than *coracana.* In Africa, only the *stricta* form is cultivated and three varieties from this are known in Abyssinia, *viz.*, *Atra.* Kcke, with black seeds ; *Fusca.* Kcke, reddish brown seeds and *Alba.* Kcke, with whitish yellow seeds. A fourth variety *genuina* from East India is referred to as the *coracana*

type. It is probable that the first cultivation of this plant was in India.

Conclusion.

In Fig. 2 is indicated the important millet areas of the Old World. Three important centres of millet cultivation and spread can be distinguished.

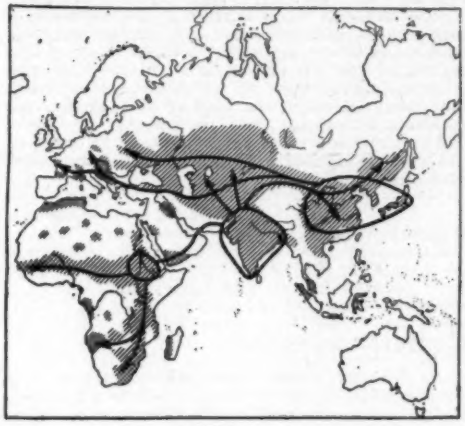


Fig. 2.

Distribution and culture centres of the millets in the Old World. Streaked area represents the regions of millet culture; Arrow lines indicate the probable direction of spread of millets: (1) in Europe from a probable centre in N. China, and (2) in the tropics from India and a secondary centre in Abyssinia.

I. *East Asiatic Millet Area.*—The home of origin of the millets *P. milliaceum* and *S. italica*. From here the spread has been westwards over East and West-Turkestan. The western stream obviously created, through cultural exchange, an easterly current of the sorghum culture.

II. *The European Millet Area.*—This area is only an area of comparatively recent introduction, the plants themselves not being native to Europe. In Europe, the most important centre is the temperate regions of the Urals.

III. *The Indian-African Millet Area.*—Comprises mainly of the three tropical millet species (*Sorghum*, *Pennisetum* and *Eleusine*). The home of origin can be placed equally in India as in Africa. Much attention has not been paid to the direction of the spread of civilisation between these two countries. There is no doubt that the spread has been in the South-Westerly direction, with scarcely any opposite currents. This means the whole of the African civilization to the south of Sahara, must have come from south or South-East Asia, and this holds good for the cultivated plants also. It is remarkable that both in India and in Africa the millet cultivation is very closely associated with the cattle-rearing. In Africa, in those provinces where the cattle-rearing takes the nomadic form, the cultivation of the millet is somewhat sparse. In Africa, south of Sahara, from the earliest times there is no evidence of the Zebu-cattle breeding; so the centre must lie outside the 'Dark' Africa. The only other great Zebu-breeding centre where the three millets are also known is India. In India and in its neighbouring countries, five varieties of domesticated cattle are to be found; all the other cattle-varieties of the world are, even to this day, wild. So it becomes obvious that India must be the original home of Zebu-rearing and also of millets. This does not in any way shut out the possibility of there being a secondary centre in Abyssinia, from where the Ethiopian culture has spread further in Africa. This African cattle-rearing region lies on the margin of the great Asiatic-European-North African agricultural (land ploughing as against picking) zone.

This becomes more clear when the cultivation of the *P. sanguinale* and *P. crusgalli* are considered (included *P. frumentaceum*, *P. miliare*, *P. colonum*, *Paspalum scrobiculatum*) (Fig. 3).

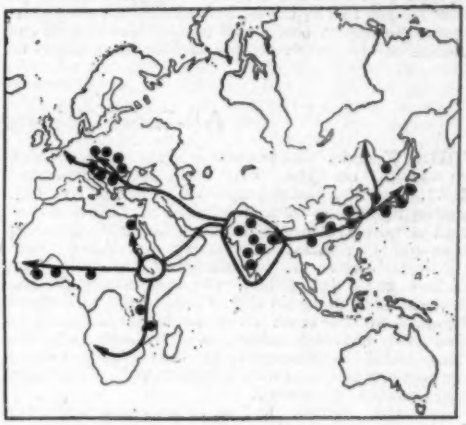


Fig. 3.

Distribution of *P. sanguinale*, *P. crusgalli* and other related millets. The black lines enclose possible starting centres of culture in India and the secondary centre in Abyssinia. The arrow lines show the direction of the culture stream—Indo-Germanic in the N.W., Ethiopic in S. W. and East-Asiatic in the N.E.

The origin of these also is probably in India. From a centre which lies more or less in India there is a current towards the North-West, the Indo-Germanic civilization stream (the Vorderasiatisch and Dinarisch races); towards the North-East, the East-Asiatic civilization stream (the Mongolian agriculturists and the Indo-Chinese 'Bingeblieder' with the Indian culture centre) and towards the South-West, the Ethiopian culture stream with a secondary centre in Abyssinia. This secondary centre sends a stream North towards Egypt, West and South. The various archæological findings make it probable that the cultivation of the millet must be at least as old as the Jungstein Age and the Indo-Germanic culture stream must belong at least to the Neolithic Age and the East-Asiatic stream must also be of the same age. Just as for the Indo-Germanic stream, the

Brachyceros-cattle and for the African, the Zebu-cattle are characteristic; so for the rice areas of the East-Asiatic, the Buffalo (Karabau) is characteristic. The area of the Buffalo-rearing corresponds to the rice culture and both lie in the South-East and must be also of the same age. The important centre of origin for the millets, therefore, is India and from here, with the various radiating civilizations, it has spread to other portions of Asia, Europe and Africa.

While the systematists and other authors are becoming more and more convinced as to the probability of Africa being the home of all the three tropical millets, the above theory comes to us as a surprise. Dr. Werth has critically reviewed all the earlier work and has struck a new path. It becomes strikingly evident from this paper that the information about the millets from India is scanty and what little is known, is vague or sometimes inaccurate. The word 'shama' is said to stand for *P. colonum*, particularly in the Punjab; in S. India, this stands for *P. miliaceum*. Similarly, the Tamil name 'Kora' and the names of the five varieties of Paspalum seem to be inaccurate. Subba Rao quotes the Sanskrit name of sorghum as 'Yavanala' (*Madras Agri. Dept. Bull.*, "Sorghum"). The existence of a Sanskrit name seems to determine the antiquity of its cultivation in India. It is not clearly known whether the cultivation of *S. italica* and *P. miliaceum* adopted in India is exotic. It devolves upon the Indian workers now, to collect all relevant data with a view to determine the antiquity of the millets, to examine the importance of each crop according to the area cultivated (both fodder and food); to ascertain the relation of the millets to the several levels of civilization and investigate the extent to which climatic and soil conditions determine the kind of crop grown. All available literature must be critically reviewed and a systematic and phylogenetic survey of the various agricultural crops with their wild relations must be conducted.

N. KRISHNASWAMY.

Muncheberg (Mark),
Germany,
September 18, 1937.

All-India Forestry Conference, 1937.

THE Foresty Conference which met at New Delhi on the 9th and 10th December 1937, was of special importance being the first gathering of the men in charge of Forest policy and administration in India, after the introduction of Provincial Autonomy in April last. 'Forests' were a 'transferred' subject even before that date; but, the operation of the Government of India Act, 1935, in the Provinces brought in its train fresh problems relating to Forest policy, education, service and research. The Delhi Conference was convened to reach agreement and evolve a common policy on these complicated questions.

All the British Indian Provinces and the leading Indian States were represented at the Conference either by their Ministers or their Chief Conservators of Forests.

The Agenda for the Conference had been prepared with care and after prolonged preliminary discussions consisted of the following items:—

1. Training of candidates at Dehra Dun.
2. (*a*) Reconstruction of the machinery of Forest administration in the Provinces. (*b*) Appointment of Conservators and Chief Conservators of Forests.
3. Staffing and distribution of posts on the India list.
4. Forest policy and the revision of the Indian Forest Act XVI of 1927.
5. Functions of the Inspector-General of Forests.
6. Utilization.

His Excellency the Viceroy, in opening the Conference, stressed the importance of Forests to Indian agriculture and indicated the directions in which the Government of India could assist Provincial Governments in regard to Forest administration. After expressing his confidence in the zeal of the Ministers to conserve and further develop the forest resources of the country, His Excellency continued, "You will agree with me that Forest administration is a subject which by its very nature does not admit, if the best results are to be achieved, of isolation within the boundaries of any single province. Efficiency to-day is achieved and maintained only by a constant effort to keep up to date, by the persistent acquisition of knowledge of general conditions and of new scientific discoveries, by comparison of method and the like. If we consider it also from another aspect, timber is a commodity of world-wide economic importance, and no producer to-day can afford to disregard the demands of his market or the technique of his competitors when that technique enables them to place better or cheaper goods on the market." His Excellency drew the analogy of the Imperial Council of Agricultural Research as an instance of the assistance which can be given to the Provinces by the Central Government in affording facilities for scientific work and for periodical discussions. The Central Government invited the Provinces to make the fullest use of the resources available at Dehra Dun for training and for research. "That existing methods and existing machinery may in certain respects need modification if they are to give the fullest value in modern conditions may well be the case···And I can assure you, too, that not only on general grounds but because of my own close and active concern with agriculture and the allied fields of plant and animal husbandry, you can rely on my personal interest in any action that may be needed in that respect." The Viceroy concluded with a special word of welcome to the representatives of the Indian States and wished the Conference every success.

In requesting His Excellency the Viceroy to open the Conference, the Hon'ble Kunwar Sir Jagadish Prasad, Member in charge of Education, Health and Lands, gave a brief resume of the evolution of Indian Forest Policy. Till 1894,

forests were regarded as mere commercial assets to be exploited commercially. "Forests are now regarded not only as valuable suppliers of timbers for commercial purposes, but as important sources for the supply of fodder for live-stock, fuel and small timber for the rural population, apart from their influence on climate, on the conservation of the water-supply, on the flow of streams and rivers and the prevention of erosion of the soil. Bitter experience has taught governments in many parts of the world that without a sound and long range policy of scientific management, irreparable damage might be done to the economic life of a country by the unrestricted destruction of forests. With the growth of population there is constant pressure to bring the more accessible forests under cultivation. Policy had to adjust itself so as to meet legitimate needs without, at the same time, destroying the sources from which those needs can be met."

After considerable discussion the Conference under the Chairmanship of Sir Jagadish Prasad, adopted the following resolutions:

1. (i) This Conference is of opinion that ordinarily there should be only one superior service in each Province, direct recruits to which should receive their training at Dehra Dun.

(ii) That, for the aforesaid training, provision should be made with effect from 1st April 1938 at the Forest Research Institute, Dehra Dun. The instruction should be of the highest standard necessary for Indian requirements.

2. The Conference is in general agreement with the principles of Forest Policy stated in the Government of India Resolution and recommends to Provincial Governments that, in any amendment of the Indian Forest Act or their Forest Manuals that they may undertake, these principles should be maintained.

The Conference also recommends that no proposal for large-scale deforestation should be approved by a Provincial Government except after the fullest consideration by the Council of Ministers. Where any such proposal is likely to affect another Province or any State, no decision should be taken except after consultation amongst the Governments concerned.

3. The Conference is of the opinion that the advice of the Inspector-General of Forests will continue to be of value to Provincial Governments and that he should, therefore, be allowed to visit Provinces with their consent. He should also be permitted to correspond with Provincial Heads of Forest Departments on technical questions so as to keep in touch with developments in each province.

The Conference elected a Committee to go into the details of the qualifications and the method of the recruitment of candidates to the new Forest College, at Dehra Dun. The Committee which met under the Chairmanship of Mr. L. Mason, President of the Forest Research Institute, Dehra Dun, submitted its report which was adopted by the Conference with minor amendments. Their Excellencies the Viceroy and Lady Linlithgow were at home to the delegates and their ladies at a Tea Party at the Viceroy's House. Sir Jagadish Prasad gave a lunch at his residence in honour of the delegates.

The Conference gave an opportunity to Forest Officers from the different Provinces to meet together and talk over matters of common interest. From these informal conversations, it was evident that the importance of research to Indian Forestry is being increasingly realised. The example of the good work of the Imperial Council of Agricultural Research is proving infectious and opinion seems to favour the organisation of Forestry Research in India on similar lines. In such a scheme, the Dehra Dun Institute may well be the central apex institution co-ordinating and assisting the work of the Provincial Research Centres.

Researches in Chemotherapy.*

THE treatment of disease by chemical substances or chemotherapy, first developed by Paul Ehrlich, originated in his observations on the selective staining of the tissues of a living animal when certain dyestuffs were injected into its body, some of the tissues being intensely stained whilst others remained colour-free. Thus when methylene blue was injected into the blood stream of an animal suffering from malaria, the malarial parasite was found to be strongly coloured and could thus be differentiated from the tissue of the host. Ehrlich was led by these observations to conceive the bold idea of discovering compounds whose chemical affinity for the disease organism would be so great that the organism might be killed without danger to the tissues of the host. The activity of a compound was expressed for purposes of comparison by what Ehrlich called his Chemotherapeutic Index, *viz.*, the ratio of the minimum curative dose to the maximum tolerated dose of the compound.

Chemotherapeutic research postulates the closest co-operation between the chemist, the biologist and the clinician. The first step is the discovery that some parasite is responsible for a particular disease after which methods have to be found for the isolation, cultivation and study of the pure parasite. This can be done sometimes in the test-tube as with bactericides and amoebicides, while in other cases, the particular disease or one closely allied to it may be produced artificially in animals and studied. The chemical side of research consists mainly in the preparation of compounds structurally related to those drugs which have already been shown to be of clinical benefit in a given disease. Once the chemical constitution of the drug has been ascertained, substances of similar molecular structure are synthesised and tested for their therapeutic properties. A good example is the discovery of Plasmoquin as a result of attempts to prepare compounds allied to quinine and the cinchona

* Summary of the Presidential Address of Dr. F. L Pyman, F.R.S., Chemistry Section, British Association for the Advancement of Science, Nottingham, 1937.

alkaloids, the medicinal value of which has been known for a long time.

Bactericides.

An early example of research on bactericides was the introduction by Lister in 1867 of phenol to prevent sepsis. Several alkyl phenols were subsequently found to exceed phenol itself in bactericidal value. Thus the Rideal-Walker test for determining the efficiency of a bactericide, which consists in comparing its effect on *B. typhosus* with that of phenol, has shown that thymol-α-methyl-isopropyl phenol—has a phenol coefficient of about 25.

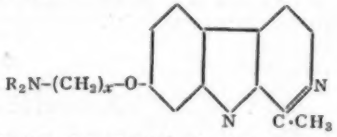
Systematic studies of the homologues of alkyl hydrocupreines by Morgenroth (1911–17), have shown that peak activity is reached with ethyl member (optoquin) for pneumococci, and with the iso-octyl member (Vuzin) for *B. diphtheriæ*. In actual clinical practice, however, optoquin has failed as a remedy for pneumonia, while vuzin has proved to be useful in the treatment of wounds. More interesting results were obtained from studies in the substituted resorcinol series by the American Chemists Johnson and Lane (1921) and Dohme, Cox and Miller (1926) who were able to demonstrate the profound effect of the length of the side chain on the antiseptic value of the alkyl resorcinol. The maximum effect was observed at 4,*n*-hexyl resorcinol which had a phenol coefficient of 50 while the next lower (*n*-amyl) and higher (*n*-heptyl) member of the series had phenol coefficients of 33 and 30 respectively. An analogous series of experiments carried out by Coulthard, Marshall and Pyman (1930) on the variation of phenol coefficients with increase in the side-chain in the 4,*n*-alkyl phenols, 4,*n*-alkyl guaiacols and 4,*n*-alkyl cresol series has led to the important discovery that the highest phenol coefficient is reached with the *n*-amyl group. 4,*n*-amyl *m*-cresol which has as high a phenol coefficient as 280, has been found to be very suitable for use as an antiseptic in the oral cavity. A dose of 1 : 10,000 added to 5 c.c. of a mouth washing reduced the bacterial colonies from 4,700 to 4 in 5 minutes and pharmacological experiments showed that it was non-toxic in medicinal doses. It has, therefore, been successfully introduced into medicine as a mouth wash.

Again, in the case of urinary infections for which phenolic bactericides have given disappointing results and which were formerly treated by giving patients a particular form of diet, known as the ketogenic diet, a study of the bactericidal properties of certain hydroxy-acids by Rosenheim and others has led to the discovery of mandelic acid as a highly potent urinary antiseptic which is non-toxic in therapeutic doses and is not oxidised in the body but is excreted unaltered in the urine. Similarly, for the specific treatment of strepto-coccal infections, certain aromatic sulphonamides have recently been found to give promising results.

Amœbicides.

Though Emetine has been the principal drug in use in the treatment of amœbic dysentery, its undesirable after effects,—particularly the nauseating effect—have led to a search for similar chemical compounds which would have its beneficial properties but be free from its by-effects. On the basis of the constitutional formula for Emetine proposed by Brindley and Pyman in 1929, a number of compounds containing two 6 : 7-dimethoxy-tetra-hydro-*iso*-quinoline nuclei joined through the 1 : 1′-positions by a chain of methylene groups was prepared and studied. When examined by the technique developed by Laidlaw, Dobell and Bishop for testing amœbicides *in vitro*, they were found to be devoid of any action in dilutions of 1 in 5,000, whereas emetine was effective even in dilutions of 1 in 500,000. Another series of compounds containing what has been termed the reduced benzpyrido-coline ring or a system in which the tertiary N-atom of the *iso*-quinoline is common to two rings, were synthesised by Child and Pyman in 1931, but the most active member of the series was found to be effective in a dilution of 1 in 25,000 only.

Substances like Harmine and Harmaline which are readily accessible in quantity by extraction from *Peganum harmala*, and which were prepared originally with a view to study their anti-malarial properties, have also failed to give promise of a powerful amœbicidal effect. In the homologues of Harmine and Harmaline where the methoxy groups have been replaced by higher alkoxy groups, the bactericidal and amœbicidal activity were found to rise up to a point and then start to fall. Peaks of bactericidal activity were reached at butyl for *B. typhosus* and at amyl for *S. Aureus* while the peak of amœbicidal activity was reached at *n*-amyl harmol. The salts of all these compounds were found to be rather sparingly soluble in water, and hence soluble derivatives had to be prepared by attaching a terminal dialkyl amino-group as in O-X-dimethyl amino-decyl harmol. In this way was made a series of derivatives of Harmol of the following general formula :



in which the size of both R and X was varied.

Among these, the O-λ-di-n-butyl amino-undecyl Harmol (R = *n*,butyl and X = 11), was found to be many times more active than O-n-nonyl Harmol and this led to the suspicion that the dibutyl amino-decyl (or undecyl) group was a more important contributor to the amœbicidal properties of these compounds than the Harmol residue. This anticipation has been confirmed by later experiments. A series of tetra-alkyl diamino paraffins of the general formula NRR′ $(CH_2)_n$ NRR′ was prepared and the minimum amœbicidal concentration under the optimum conditions for emetine was determined. Among these the decane derivatives gave very encouraging results and surpassed in their effects even the dibutyl amino-undecyl harmol referred to above. The peak in the series was reached with the tetra-amyl-diamino-decane which may be referred to for brevity as T.A.D.D. Other compounds were next synthesised in which (*a*) the hydrocarbon residue was varied keeping the tetra-alkyl group constant, and (*b*) the tetra-alkyl

group was varied while the hydrocarbon residue was kept constant, but none of these products showed any striking amœbicidal effects. A more detailed study of T.A.D.D. was then undertaken, the conditions of all the amœbicidal tests being those most favourable to emetine, *i.e.*, in a faintly alkaline medium. T.A.D.D. was thus found to be 3 to 5 times as efficient as emetine at a P_H of 6·2 to 6·3. Experiments with mice, again, showed it to possess only one-tenth of the toxicity of emitine when administered orally, and one-sixth on subcutaneous injection. It is therefore clear that its therapeutic index is superior to that of emetine and T.A.D.D. appears now to be an exceptionally promising compound for clinical trial in conditions of ill-health due to infestation with *Entamœba histolytica*. Clinical examination of the compound by the Trials Committee of the Medical Research Council has, however, shown that the compound when administered orally, is not sufficiently active to be of real value while its intensely irritating nature has prevented its use intramuscularly, subcutaneously or intravenously.

The foregoing account of investigations in Chemotherapy should give one an idea of the enormous amount of chemical and biological work requiring team-work among groups of chemists, biologists and clinicians, which is involved in attempts to evolve a new drug for the treatment of disease. There are very few private concerns which can provide facilities for such co-operation and it is therefore gratifying to note that lately work of this character is being undertaken under public auspices, such as the work on anti-malarials directed by Prof. Robinson under the Chemotherapy Sub-Committee of the Medical Research Council and that on arsenicals by Sir Gilbert Morgan under the Department of Scientific and Industrial Research.

B. B. Dey.

SCIENCE NOTES.

New Year Honours:—

C.I.E.—Dr. C. W. B. Normand, Director-General of Observatories, Government of India.

Knight Bachelor—Dr. Zia-ud-din Ahmed, Vice-Chancellor, Aligarh Muslim University.

O.B.E.—Mr. R. C. Srivastava, Director, Imperial Institute of Sugar Technology, Cawnpore.—Capt. T. W. Bernard, Director, Bernard Institute of Radiology, Madras.

* * *

Indian Vegetable Oils.—The *Bulletin* of Indian Industrial Research, No. 10 (By N. Brodie, M.SC., A.I.C., Director, Industrial Research Bureau; Published by the Manager of Publications, Delhi, 1937; pp. 116; As. 6) is a valuable compilation systematically recording the physical, chemical and economic characteristics of about 129 Indian vegetable oils. These have been broadly classified into 24 drying oils, 27 semi-drying oils and 78 non-drying oils, and represent as many as 55 botanical families.

The sources of information have been not only the Governmental publications in the Museum, Agricultural Industries and Forest Departments, but also Journals of the Imperial Institute, Indian Institute of Science, Indian Chemical Society, Indian Institute of Chemistry, and the Society of Chemical Industry. Information has also been drawn from unpublished records of the Government Test House, Alipore, and the Harcourt Butler Institute at Cawnpore.

The review has summarised all fatty work done to the end of 1936, and contains very few errors, omissions or mis-statements. It is well known that, owing to its favourable climate, India is the second largest producer of oil-seeds in the world, and that the oils derived therefrom are in great demand all over the world for a variety of essential, edible, industrial and medical purposes.

The present publication is a valuable handbook of reference to the business man as well as to the chemist, drawing their attention to the lesser known but abundantly occurring oil-seeds of the country, for their future exploitation for the one or the other of the various uses to which they have been pointed out to be suitable. The thanks of the English-knowing industrial public are due to the author for his thoughtful compilation and to the Government of India for its low price.

* * *

All-India Institute of Hygiene and Public Health.—The *Annual Report* of the Institute for the year 1936, recently issued, gives a brief account of its activities and is an impressive record of another year's progress. It may be recalled that the Institute was established from funds (17·87 lakhs) provided by the munificence of the Rockefeller Foundation, New York, U.S.A. The responsibility for its maintenance was undertaken by the Government of India. The Institute provides advanced training for public health workers on an all-India basis.

In the year under report, side by side with basic researches, a number of investigations bearing on public health problems of the country were conducted. One such problem to receive the attention of the research staff was *Cholera*. The causes of epidemicity of cholera in Bengal were investigated and from a statistical analysis of recorded cholera mortality in different parts of Bengal it was found that only certain areas were definitely endemic. The information collected from these areas will be useful in clarifying certain points in regard to the cholera problem. Researches on the chemical constitution of cholera vibrios in relation to the virulence of the organism and simpler methods for determining the chemical constitution of these vibrios will be of help to workers in the field. Statistical studies were carried out with a view to develop a method for forecasting cholera epidemics and so to forewarn public health authorities.

Special attention was paid to the study of epidemic dropsy. The interesting observation that certain supplies of mustard oil when fed to human volunteers, produced symptoms of epidemic dropsy, was made during the year. The

nature of the poisonous substance and the source from which it is derived are being investigated (*cf.* this *Journal*, 1937, **6**, 247).

The salt and vitamin contents of many of the Indian food-stuffs have been investigated. It is suggested that fat and meat should be consumed along with green vegetables and carrots, which combination helps in the absorption of carotene, the main source of vitamin A, in India.

In the Malaria section attention was directed towards the investigation of the causes and treatment of black water fever prevalent in highly malarious localities. From the studies of similar conditions in monkeys, it has been found that the disease is due to a disturbance in the balance of chemical constituents of blood brought about by lesions in the liver and adrenal glands. Partial success has been obtained in the treatment of the disease by adopting a procedure based on these findings.

Investigations on the spread of malaria were conducted during the year. Research on why a Culificacies does not carry malaria in Bengal as it does in other parts of India is being investigated.

The problem of maternal mortality received considerable attention. It was found that 94 per cent. of the deaths was due to a preventable factor, *viz.*, infection arising out of uncleanliness during child birth.

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An Analysis of the Factors Affecting Road Friction.—Results of measurements of the "braking force coefficients" derived from straight ahead skidding by means of the single-wheel trailer apparatus are given in the *Technical Paper* recently issued by H. M. Stationery Office (*Road Research Technical Paper* No. 2. Price 1*s*.). The "laws of road friction" are formulated and a "Model law" has been derived which would enable skidding to be studied by means of models. A method of calculating stopping distances is presented.

* * *

Report of the Forest Products Research Board for the Year 1936.—The Report of the Forest Products Research Board for the year 1936 (His Majesty's Stationery Office) gives a very interesting account of the investigations carried out during this period at the Forest Products Research Laboratory, into the structure, seasoning and fireproofing of timbers, both home-grown and imported, as well as their working qualities, physical properties, preservative treatment and chemical composition. The report, which also describes many ways in which the Laboratory can assist industry in solving problems in timber utilization, cannot fail to be of interest to all those concerned in any way with the handling of timber.

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Michael Faraday's "Ray-Vibrations".—A report in the *Manchester Guardian* refers to the discovery of a very important letter of Michael Faraday in a bundle lying in the safe of the Royal Society. "It had been put there for safe keeping with many others. A short time ago, in getting out other papers, the letter was noticed and as no prohibition could be found relating to it, it was decided to open it. A day was fixed and Sir William Bragg, in the presence of a number of Fellows and other distinguished scientists, broke the seal and read the letter."

The letter in the words of Sir William Bragg, "Shows that Faraday was at that early period entertaining the idea that the 'diffusion' of magnetic and electric forces was comparable with the spread of waves on water or in air, and had indeed a vibrating character". "We all knew Faraday had these ideas. What surprised us was that he had them so early. He had talked about his ideas in 1846 when he gave a lecture at the Royal Institution which he afterwards published under the title of 'Thoughts on Ray Vibrations'.

"That led Maxwell to write his paper in 1865 on the electro-magnetic theory of light, in which he deduced mathematically that there should be electro-magnetic waves which would travel with the speed of light. Until this letter was opened there had been no indication that Faraday's thoughts on ray-vibrations had been simmering for so long. Faraday apparently did not pursue the matter because he was so terribly busy, and experimental difficulties were very great."

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Laxminarayan Technological Institute, Nagpur.—The Foundation Stone of the Laxminarayan Technological Institute was laid by His Excellency Sir Hyde Clarendon Gowan, B.A., K.C.S.I., C.I.E., V.D., I.C.S., J.P., Chancellor of the Nagpur University, at Nagpur on the 8th December 1937.

The Chancellor paid a tribute to the untiring efforts of the present Vice-Chancellor Dr. Sir Hari Singh Gour, Kt., M.A., D.C.L., LL.D., D.Litt., in acquiring the present site for the Institute which will command a charming scenery all round it.

The construction of the Laxminarayan Technological Institute and its workshop is the result of a princely bequest now amounting to over £400,000, made by the late Rao Bahadur D. Laxminarayan in 1930 to the Nagpur University for the teaching of Applied Science and Chemistry. The University has decided to make a start with the creation of a Department of Applied Chemistry for the teaching of and research work in this subject.

Dr. R. S. Thakur, D.Sc., F.I.C., who had been deputed for the last two years by the Nagpur University to England and the Continent for practical training in Applied Chemistry with special reference to Oil Technology, has now been appointed as the Organising Officer. It is expected that the Institute will start functioning from July 1939.

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The 150th Anniversary of the Royal Botanic Garden was celebrated on the 6th January. The Nawab Bahadur of Dacca presided.

Dr. K. Biswas gave a short history of the Gardens. Sir James Jeans and Sir Arthur Hill, on behalf of the British Delegation of scientists, Dr. J. van Manen, on behalf of the Royal Asiatic Society of Bengal, Dr. S. P. Agharkar and Prof. P. Parija, on behalf of the Indian Botanical Society, offered their felicitations.

The Garden contains 1,500 specimens under cultivation and offers enormous scope for the study of tropical flora.

Society of Biological Chemists, India.—The Seventh Annual General Meeting of the Society was held in the Baker Laboratories, Presidency College, Calcutta, on Tuesday, the 4th January 1938. Rai Bahadur Sir Upendranath Brahmachari opened the meeting after which Dr. Gilbert J. Fowler presided. The Meeting adopted the Annual Report presented by the Executive Committee and resolved to start a Reserve Fund for the Society, towards the nucleus of which a donation of Rs. 100 was announced from Sir Upendranath Brahmachari. The General Body adopted a number of changes in the Rules.

Rai Bahadur Sir Upendranath Brahmachari was re-elected President of the Society. Dr. C. N. Acharya and Mr. B. H. Iyer were elected Hon. Secretaries.

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At the **Annual General Meeting of the Indian Economics Association**, held on 31st December 1937 at Hyderabad, Dr. Gyanchand, Patna University, was unanimously elected President for the next session of the Conference to be held at Nagpur. Dr. B. V. Narayanaswamy Naidu of the Annamalai University was re-elected General Secretary.

* * *

National Academy of Sciences, India.—The following members of the Academy were elected as Fellows at the meeting, held on the 18th December 1937:—(1) Dr. G. R. Toshniwal (*Allahabad*), (2) P. K. Sen Gupta (*Kolhapur*), (3) Dr. Rajnath (*Benares*), (4) Dr. A. B. Misra (*Benares*).

The subject for the award of the Education Minister's Gold Medal, has been announced. This medal is awarded for the best research paper published in the *Proceedings of the National Academy of Sciences, India*. The subject chosen for the award in 1938, is "Mathematics including Astronomy".

Dr. S. Dutt, D.Sc. (London), of the Allahabad University, has been awarded the *Education Minister's Gold Medal* (U.P.) for researches in Chemistry for the year 1937.

* * *

The Imperial Council of Agricultural Research has allotted funds for the following schemes during the year 1938-39:—

(1) Sewage farm investigations with special reference to papaya and plantain cultivation (Indian Institute of Science). (2) Water requirements of crops in the Punjab. (3) Investigations into the attack on Jowar by the parasite Striga by the Economic Botanist, Bombay. (4) Research on coconuts in the Madras Presidency. (5) Scheme of gas storage of the fruits and vegetables, Bombay. (6) Extension of the research scheme for studying soil problems in Bengal (7) Cinchona Enquiry. (8) Scheme by Dr. Lander for determining the feeding values of certain food grains, oil-seeds and oil-cakes. (9) Punjab indigenous goat breeding scheme. (10) Toxicology of Indian drugs (Madras Scheme). (11) Grant for sending an officer of the Punjab Veterinary Service on deputation to South Africa to study the Angora Goat Industry (Punjab Scheme).

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Dr. G. D. Bhalerao, D.Sc., Ph.D. (London), F.Z.S., F.R.M.S., F.A.Sc., Helminthologist, Imperial Veterinary Research Institute, Muktesar, has been appointed by the Secretary of State for India to write a volume on *Trematoda* in the "Fauna of British India" series. In this series only the best authorities are selected for writing volumes on the subjects in which they have specialised. Dr. Bhalerao has had a very successful career at the Universities of London and Allahabad and he holds the Doctorate degrees of both these Universities. He is the author of the book *Helminth Parasites of the Domesticated Animals in India* and numerous memoirs on worm parasites.

* * *

Dr. Debendra Mohan Bose, Ph.D. (Berlin), M.A., B.Sc., Palit Professor of Physics at the Calcutta University, has been appointed Director of Bose Research Institute in succession to the Late Sir Jagdish Chunder Bose. Third son of the Late Dr. Mohini Mohan Bose and nephew of the Late Sir Jagdish Chunder Bose, Dr. D. M. Bose has carried out investigations on radio-activity, magnetism and spectra of crystals. He represented India at the International Congress of Physicists in Italy in 1927 in connection with the Volta Centenary.

* * *

At a Special Convocation of the University of Calcutta, held at the Government House on the 7th January, the Degree of Doctor of Laws was conferred on the following:—

Sir James Hopwood Jeans, Professor Francis William Aston, Professor Ernest Barker, Professor Arthur Henry Reginald Buller, Sir Arthur Stanley Eddington, Professor Charles Gustave Jung, Professor Charles Samuel Myers, and Professor Walter Straub.

Welcoming the recipients of the degrees Mr. Shyam Prasad Mookerji, the Vice-Chancellor, said that the distinguished representatives of science and culture might differ from one another in many respects but they were all bound by one common bond, of thought and action. They were all votaries of knowledge and they believed steadfastly in the progress of human thought and civilization. "In the field of scholarship and knowledge, let unity, harmony and equity rule the relations between the East and the West and permanently create an atmosphere of genuine understanding and friendliness which will prove a valuable asset for the preservation of peace and stability in the world."

* * *

Benares Hindu University.—The Twentieth Convocation of the Benares Hindu University for conferring degrees was held on the 28th December in the spacious amphitheatre. The Maharaja of Benares, Pro-Chancellor, presided.

Honorary Doctorates were conferred on seven members of the British Delegation of scientists, namely, Sir James Jeans, Sir Arthur Eddington, Dr. F. W. Aston, Professor E. C. C. Baly, Prof. V. H. Blackman, Prof. C. G. Jung and Prof. F. A. E. Crew.

Pandit Malaviya, Vice-Chancellor, announced a donation of Rs. 50,000 from the Maharaja of Kotah.

* * *

Announcements.

Annual Review of Physiology.—Announcement is made of the forthcoming publication of an "*Annual Review of Physiology*" in which it is proposed to review at annual intervals the developments of the preceding year or biennium in the major fields of physiological reserach. The series will appear under the auspices of the American Physiological Society, Inc., and the Annual Review of Biochemistry, Ltd. The new *Review* will conform in general style and format to the *Annual Review of Biochemistry*. The Joint Board of Management is to consist of Chauncey D. Leake (University of California), J. Murray Luck (Stanford University), W. J. Meek (University of Wisconsin), and Carl L. A. Schmidt (University of California). The Editorial Committee comprises A. J. Carlson (University of Chicago), J. F. Fulton (Yale University), M. H. Jacobs (University of Pennsylvania), F. C. Mann (University of Minnesota and the Mayo Foundation), and W. J. Meek (University of Wisconsin). J. Murray Luck will serve as Managing Editor. The first volume is expected to appear in February 1939.

The International Congress of Geography will be held at Amsterdam from July 18–28, 1938.

The International Congress of Anthropology and Ethnology.—The Second Session of the International Congress will meet at Copenhagen under the Presidentship of Dr. Frans Blom, Director of the Department of Middle American Research at Tulane University of Louisiana, from August 1–6, 1938.

The Conference will conduct the discussions under the following sections:—Physical Anthropology, Psychology, Demography, Ethnology, Sociology and Religion, Linguistics and Writing.

The new National Museum will be opened on this occassion by the King of Denmark and Iceland.

The All-India Population and Family Hygiene Conference will be held at Bombay from the 16th to 19th April, 1938 (Easter Holidays), and not in January as originally announced. Members and Delegates wishing to submit papers and attend the sessions should write early to the Honorary Secretaries at No. 8, Ormiston Road, Appollo Bunder, Bombay.

Indian Science Congress.—The next session of the Congress will be held at Lahore, at the invitation of the Punjab University, from January 2–9, 1939. Prof. Dr. J. C. Ghosh, Professor of Chemistry, Dacca University, has been appointed General President of the Congress.

The following have been elected Sectional Presidents:—(1) PHYSICS: Dr. K. R. Ramanathan (*Poona*); (2) CHEMISTRY: Dr. P. B. Sarkar (*Calcutta*); (3) GEOLOGY: Prof. S. K. Roy (*Dhanbad*); (4) BOTANY: Dr. K. D. Bagchi (*Dehra Dun*); (5) ZOOLOGY: Prof. C. R. Narayan Rao (*Bangalore*); (6) ANTHROPOLOGY: Dr. D. N. Majumdar (*Lucknow*); (7) AGRICULTURE: Dr. T. V. Ramakrishna Aiyar (*Coimbatore*); (8) MEDICINE AND VETERINARY RESEARCH: Prof. T. S. Tirumurthy (*Madras*); (9) PHYSIOLOGY: Dr. S. M. Basu (*Calcutta*); (10) PSYCHOLOGY: Dr. H. P. Maiti (*Calcutta*).

* * *

We acknowledge with thanks, rece pt of the following:—

"Agricultural Gazette of New South Wales," Vol. 48, No. 12.
"Agriculture and Live-Stock in India," Vol. 7, No. 6.
"Arkiv fur Zoologie," Vol. 29, No. 3.
"Biochemical Journal," Vol. 31, No. 11.
"Berichte der Deutschen Chemischen Gesellschaft," Vol. 70, No. 12.
"Bulletin of the Health Organisation of the League of Nations," Vol. 6, No. 4.
"Bulletin of the American Meteorological Society," Vol. 18, No. 10.
"Bulletin of the Geological Institution of Upsala," 1937.
"Bulletin of Cornegie Institution of Washington", Vol. 14, Nos. 14–16.
"Chemical Age," Vol. 38, Nos. 961–64.
"Communications from the Boyce-Thomson Institute," Vol. 9, No. 2.
"Calcutta Medical Journal," Vol. 32, No. 12.
"Canadian Journal of Research," Vol. 15, No. 11.
"Experiment Station Records," Vol. 76, No. 6.
"Forschungan und Fortschritte," Vol. 13, Nos. 34–36.
"Journal of the Royal Society of Arts," Vol. 85, Nos. 4436–39.
"Journal of the Indian Botanical Society," Vol. 16, No. 6.
"Journal of Chemical Physics," Vol. 5, No. 12.
"Journal of the Indian Chemical Society," Vol. 14, Nos. 9–10.
"Journal de Chemie Physique," Vol. 34, No. 11.
"Journal of the Mining and Metallurgical Institute of India," Vol. 33, Part 2.
"Journal of the Indian Mathematical Society," Vol. 2, No. 8.
"Journal of Nutrition," Vol. 14, No. 6.
"Journal of the American Museum of Natural History," Vol. 40, No. 5.
"Monthly Bulletin of Agricultural Science and Practice," Vol. 28, Nos. 11 and 12.
"Medico-Surgical Suggestions," Vol. 6, No. 12.
"Mathematics Student," Vol. 5, No. 2.
"Nature," Vol. 140, Nos. 3551–56.
"Nagpur University Journal," Nos. 1 and 2.
"Nagpur Agricultural College Magazine," Vol. 12, No. 2.
"Philippine Agriculturist," Vol. 26, No. 7.
"Transactions of the Faraday Society," Vol. 33, No. 200.
"Science and Culture," Vol. 3, No. 6.
"The Sky," Vol. 2, No. 2.
"Indian Forester," Vol. 64, No. 1.
"Indian Trade Journal," Vol. 126, Nos. 1642–46.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

December 1937. SECTION A.—K. L. RAMASWAMY: *Dielectric Polarisation and the Form of the Carbon Dioxide Molecule.*—There is no change in the polarisation over the range 20° to 210° C., indicating that the gas is non-polar and that there is no change in the shape of the molecule at 145° C. as postulated by Ibbs and Wakemann. M. K. THOMAS AND D. C. MANDEVILLE: *The Electrical Conductivity of Potassium Chloride in Methyl Alcohol-Water Mixtures.*—The conductivity decreases on addition of alcohol to a minimum at 70–80 per cent., and when the conductivity is plotted against $\sqrt{c}$ for any mixture, maxima and minima are obtained. The latter is explained on the basis of solvation in steps. K. SATYANARAYANA MURTY, P. SURYAPRAKASA RAO AND T. R. SESHADRI: *Geometrical Inversion in the Acids derived from the Coumarins. Part VI. The Behaviour of the Acids Derived from 4-Methyl-Coumarins.*—The acids and their ethers derived from 4-methyl-coumarins are *trans*-compounds. The ready formation of the acids and their reconversion to coumarins are due to the tautomeric mechanism which renders the geometric inversion very facile. R. K. ASUNDI AND S. MUJTABA KARIM: *On the Emission Spectrum of CCl_4.* D. S. SUBBARAMAIYA: *Diffraction of Light by Ripples on Liquid Surfaces. Part I.* By employing the diffraction method, a quantitative study has been made of the damping of progressive ripples on the surface, and also of the damping of ripples due to surface contaminations. The distribution of intensity in the spectra is a function of the amplitude of the ripples, the problem being similar to the one discussed by Raman and Nath in their paper entitled "Diffraction of Light by High Frequency Sound Waves". BAWA KARTAR SINGH AND BHUTNATH BHADURI: *Studies on the Dependence of Optical Rotatory Power on Chemical Constitution. Part XV.—Chloroaryl Derivatives of Stereoisomeric Methylenecamphors.*

SECTION B.—C. BHASHYAKARLA RAO: *The Myxophyceæ of the United Provinces, India—III.*—Deals with algæ, hitherto unrecorded, collected from Benares and its environs from 1934 onwards. One hundred and five forms, representing twenty-five genera and out of these, two species, sixteen varieties and twenty-seven forms are new. M. V. KOTASTHANE AND N. NARAYANA: *The Proteins of Groundnut (Peanut)* Arachis hypogæa, *Linn.*—A detailed chemical analysis of the proteins of groundnut is reported. A comparison of the amino-acid made up of the globulins of groundnuts and the total proteins of soyabean indicates that the nutritive value of the proteins of groundnut is superior to that of soyabean. C. R. NARAYAN RAO: *On Some New Forms of Batrachia from S. India.*—The distribution, mode of occurrence and general habits of the anuran fauna, collected from selected types of localities marked by distinctive physical features in South India, have been recorded. (MISS) CHINNA-VIRKKI: *On the Occurrence of Winged Spores in the Lower Gondwana Rocks of India and Australia.*—The two winged spores show a striking resemblance to Prof. Seward's *Pityosporites antarcticus*, and as was suspected by him in the case of his specimens, most probably belong to the pollen grain of *Glossopteris.*

National Academy of Sciences, India:

December 18, 1937.—K. B. MATHUR: *Ionization in the F-layer before sunrise.* A. B. SEN: *Action of Para-toluene-sulphonic chloride on Phenols containing azo groups.*

Indian Chemical Society:

September 1937.—J. C. GHOSH, T. BANERJEE AND S. K. MUKHERJEE: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part I.—Tungstic Acid, Molybdic Acid, Chromic Tungstate, etc., as Photo-active Reagents. Optical properties of these Sols; Circular Dichroism in the Ultra-violet.* J. C. GHOSH, T. BANERJEE, S. K. BHATTACHARYA AND S. K. DAS GUPTA: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part II.—Photochemical Reduction of Tungstic Acid Sol by Glucose, Lævulose, Formaldehyde, Lactic Acid, Sodium Hypophosphite, Leucine and Glutamic Acid.* J. C. GHOSH, T. BANERJEE AND MD. SURAT ALI KHAN: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part III.—On the effect of pH on the Photoreduction of Tungstic Acid Sol in Unpolarised Light.* J. C. GHOSH, T. BANERJEE, K. M. BHATTACHARYA AND MD. SURAT ALI KHAN: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part IV.—Photochemical Reduction of Molybdic Acid Sol by Glucose, Formaldehyde, Ethyl Alcohol, Sodium Hypophosphite, Leucine, Glutamic Acid and α-Alanine.* J. C. GHOSH, T. BANERJEE AND MD. SURAT ALI KHAN: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part V.—On the effect of pH on the Photoreduction of Molybdic Acid Sol in Unpolarised Light.* J. C. GHOSH, T. BANERJEE AND S. K. BHATTACHARJEE: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part VI.—Photochemical Reduction of Vanadic Acid Sol with Ethyl Alcohol in Acid Medium.* J. C. GHOSH, T. BANERJEE AND J. C. BOSE: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part VII.—Photochemical Reduction of Uranic Acid Sol by Sodium Tartarate.* M. L. KUNDU, S. S. DE AND B. N. GHOSH: *Enzymes in Snake-venom. Part III.—Effect of Temperature and Chemicals on their Activity.* NIHAR KUMAR DUTT: *A Note on the two Different Modifications of Cobalt Quinaldinate.*

October 1937.—TARAPADA BANERJEE AND J. C. GHOSH: *Photochemical reaction with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part VIII.—On the Internal Filter Action of Reduced Tungstic Acid and Molybdic Acid Sols.* J. C. GHOSH, T. BANERJEE, S. K. NANDY AND N. GUPTA: *Photochemical Reaction with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part IX.—The Photochemical Oxidation of Alcohol and Glucose by Iodine in Acid Medium with Tungstic Acid Sol as Photosensitiser.* J. C. GHOSH, T. BANERJEE AND S. K. BHATTACHARJEE: *Photochemical Reaction with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part X.—On the Photochemical Oxidation of Glucose by Potassium indigo-tetrasulphonate with Tungstic Acid Sol as Photo-catalyst.* J. C. GHOSH, T. BANERJEE AND J. C. BOSE: *Photochemical Reactions with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part XI.—The Photochemical Oxidation of Glucose by Methylene Blue with Uranic Acid Sol as Photosensitiser.* T. BANERJEE, S. K. BHATTACHARJEE AND N. MUKHERJEE: *Photochemical Reaction with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part XII.—The Photochemical Oxidation of Glucose and Lævulose by Methylene Blue with Ferric Hydroxide Sol as the Photosensitiser.* TARAPADA BANERJEE: *Photochemical Reaction with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part XIII.—Influence of State of Polarisation of Light on the Velocity of Photo-Oxidation of Organic Substances by Hydrogen Peroxide with Colloids as Photosensitisers.* J. C. GHOSH AND T. BANERJEE: *Photochemical Reaction with some Inorganic Colloids as Active Agents under the Influence of Light in various States of Polarisation. Part XIV.—Influence of Circularly Polarised Light on Photochemical Reactions with pre-excited Colloids as Photosensitisers.* K. GANAPATHI: *Synthesis in the Alloxazine, iso-Alloxazine (Flavin) and Lumazine Groups. Part I.—Synthesis of 6- or 7-Phenol and 6 : 7-Diphenyllumazines.* J. K. CHOUDHURY AND M. A. SABOOR: *Oxidation of Hydrocarbons in the Vapour Phase. Part I.—Aromatic Hydrocarbons.* J. K. CHOUDHURY AND M. A. SABOOR: *Oxidation of Hydrocarbons in the Vapour Phase. Part II.—Hydroaromatic Hydrocarbons.*

Indian Botanical Society:

December 1937.—F. BOERGESEN: *Contributions to South Indian Marine Algal Flora—Part II.* S. N. DAS GUPTA: *On the culture behaviour of a species of* Rosellinia. *Part I.—Inhibitory effect of certain chemicals on the production of perithecia.*

Association of Economic Biologists, Coimbatore:

November 15, 1937.—P. VENKATARAMIAH AND C. RAGHAVENDRACHAR: *The Colour of Black Soils—The Influence of Organic Matter.*—The examination of a number of black soil profiles, leads to the conclusion that the dark colour of the soil is due to the association of organic matter with a clay having a high SiO_2/R_2O_3 ratio and a Ca and Mg silicate complex which gives a darker colour to an already grey soil. T. V. RANGASWAMI: *Absorption of Soil Moisture during Germination in Cotton Seed.*—Different varieties of cotton seeds were examined. It was observed that water enters the embryo through the seed-coat in addition to the micropyle, during germination.

December 1, 1937.—P. D. KARUNAKAR, M. SANYASI RAJU, R. RAJAGOPALAN AND M. SUNDARAM: *Investigations on the Decomposition of Molasses under Paddy Soil Conditions.*—The death of paddy seedlings when transplanted soon after the application of molasses to paddy soils, is due to (1) Displacement of oxygen by CO_2, H and methane evolved in considerable quantities and (2) Production of organic acids and the dissolution effect they may have had on minerals. These effects pass off after about two weeks.

December 22, 1937.—C. R. SREENIVASA AYYANGAR AND S. RAMANUJAM: *Induction of Somatic Mutations as a Method of Crop Improvement in Rice.*—The cause of the occurrence of the mutations and the method employed for artificially producing them and their importance in practical breeding are discussed. V. RAMANATHA AYYAR: *India and the Present Cotton Situation.—A General discourse.*

Errata.

Vol. VI, No. 3, September 1937.

Review entitled "Lectures on College Algebra":

Page 121, Column 1—(1) line 22, *for* 'then' *read* 'them'; (2) line 36, *omit* the repeated portion, *viz.*, "into the fabric of which are oven the tissues"; and (3) line 39, *for* "Choherent" *read* "Coherent".

Vol. VI, No. 5, November 1937.

(1) Contribution entitled "The Thermodynamics of Duststorms":

Page 209, Column 1, last line, and Column 2, first line *for* "following table gives the monthly frequencies of duststorms brought out by this analysis" *read* "following table gives the monthly distribution of these 152 duststorms as brought out by this analysis".

(2) Contribution entitled "Diagonsis of Colour Defect":

Page 252, Column 2, line 3, *for* "field" *read* "first".

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